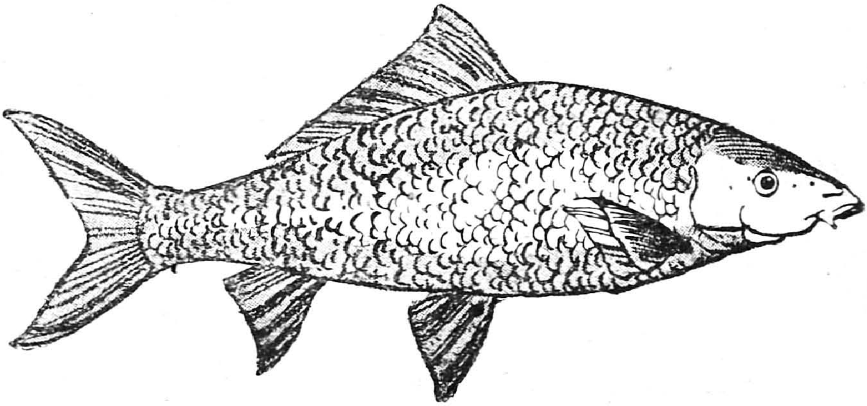
A Symposium on

FISH CULTURE

A Practical and Comprehensive guide on Inland Fish Farming.



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PREFACE.

Fish Farming is receiving increased attention from all parts of the country as of Vital importance for auge menting food resources. Fish Culture requires less labour and outlay of capital than agriculture and it is not dependent on the agriculturist's great bugbear 'the changes of weather.' It is an established fact that a fish pond is more profitable than an equal area of good land. A youth in India with a capital of Rs. 1,000/-, made out Rs. 75,000/- in one year by judicious fish farming. Any body with a little knowledge of the subject and perseverence can take up to Fish Culture profitably and this line, offers good opportunities for the enterprising youth.

Literature dealing with fish culture is much scattered and the concerned publications are not easily avilable to one and all. With a view that an honest effort in collecting all the material available on the subject would prove advantageous to those interested, this book is compiled from the writings of wellknown experts on the subject such as Dr. Hora, Dr Soundararaj, Dr. Baini Prasad, Dr. Day and others. No originality is claimed and a list of books and periodicles consulted in the pre-

paration of this Synopsis has been appended to this book. To assist the students of Inland Fish Culture, material has been arranged according to the syllabus followed by the Madras Government Fisheries Department for training candidates in Fish Culture.

I am indebted to Messrs. D. D. Peter Devadas Dy. Director of Fisheries and N. Jagannatham, Assistant Director of Fisheries Madras for giving facilities to Lokareddi in preparing notes on Fish Farming during his practical training in the subject and this book is compiled from the same notes. I am greatful to Sri G. Ramalingeswara Rao, for his kind help in getting the blocks of various fishes printed in this book and to Sri P. Sethunarayana-Rao for enthusiastically printing this book without taking any consideration for his pains.

I shall consider my efforts in preparing this digest are sufficiently remunerated if it is of any practical help to the enterprising youth interested in the subject. Any corrections and advice to improve this book, will be greatefully received.

V. Satyanarayana.

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CHAPTER I.

History of Pisciculture.

Fish culture in ponds is a very ancient industry. It is probable that the Chinese were the first to practice it on a large scale and even now they are among the most skilful pisciculturists in the world. The earliest pisciculturist in China is said to have lived in the 5th Century B. C. The ancient Romans had their fish ponds and fabulous sums were spent on their up-keep. In European countries in the middle ages, every monastry and every manor had its own fish pond. In Central and Southern Europe, large farms and estates and even hotel gardens still retained their fish ponds. In Germany, fish culture is practised on a very large scale and farms are run on a commercial basis. Some of these fish farms may be as much as six or seven thousand acres in extent. In Austria, a derelict canal bed is used by the largest establishment for its ponds. In Italy, the controlled waters of an eel farm are many miles in length.

Importance of fish industry.

It will be noticed, that even in progressive countries with rapid communications and modern preservative methods of transport, it is still considered worth while for Government to encourage and support fish culture and fish farms on a commercial basis. How much greater should be the need and the opportunity for such an industry in a sub-continent such as India, where communications are wholly inadequate and distance prohibitive,

where modern methods of transporting fresh fish are practically unknown and the climate such as to make food putrified much more rapidly than in temperate regions, while the majority of the people are non-vegetarians and only too glad to eat fish, if they can obtain it.

Fish in the diet.

The poor diet of a large proportion of the population, particularly in rice eating areas has begun to engage the attention of all those who are concerned about material help. The coming of milled and polished rice has robbed the stapple food of many people of its most valuable qualities. The addition of fish is good if it could be made available and this would go far to correct the deficiency and make a more balanced diet. It is claimed that the fish is the best connective to the rice diet. Here are many other people also who would welccme fish for variety and for the value, which they know, it possesses as food. The fresh fish is within the reach of almost every agriculturist and it is as profitable a crop raised as any other, since water is absolutely necessary for the cultivation of any land crop, a small amount of labour and a nominal expenditure will in all probability be sufficient for the farmer to add valuable source of food supply to the family manu and possibly in addition, supply him with an extra source of revenue.

Regular fish farmers.

Besides the utilisation of paddy fields for fish culture, there are the regular fish-farms such as

those near Tokyo already mentioned. Here fish both young and old have to be fed as the ponds are small and contain little natural food, while the fish are crowded into them in large numbers. In some districts, the pupae of the silk worm after the silk has been removed forms the principal food for fish. The fish so fed needed special feeding course before marketing. The utilisation of waste product such as the silk work pupae, for feeding fish is a striking example of how the Japanese waste neither the spades nor the materials. Carp, eels and mullets are frequently grown togother. The yield from these ponds according to the figures given, seems incredible; but it is by no means impossible. Properly fed carp will grow 20 inches within 2 years.

Sir F. Nicholson visited 3 Farms near Tokyo. One belonging to the Fishery Society and 2 others to business firms. The area of the Fishery society farm was only 7 acres with 3 large ponds, covering nearly 6 acres used for growing fish for market. The remaining area was divided into 11 small ponds for breeding, experimental and other purposes. The 3 ponds were said to have produced in five years, more than 20,000 lbs., of carps and a large number of mullets, that is to say, the yield was more than 8,000 lbs., carp per acre. Another establishment produced 1,800 carp per acre and probably an equal amount of eels and grey mullets would be grown simultaneously in the same ponds. Very large yields have also been obtained in American farms, where cheap artificial food was available.

Fish culture as an industry in India.

It will be seen from what is being done in other countries, the fish culture in ponds is no new thing and that it is merely a by-product. It will add considerably to the wealth of the agriculturist. In India, this industry is almost non-existent and the question to be considered is, if there is any scope of such an addition to the farmer's income.

Places suitable for fish culture in India.

The first requisite is ofcourse water situable for fish culture. It will be seen that the water need not be permanent for the farmer to fatten a few fish at least for his own use, provided he can buy the fry at the beginning of the season. Apart from the big tanks, there are many available water areas which now either are growing a few wild coarse fish or merely form the breeding places for mosquitoes. Just below a tank bund, there is often a marshy area, too wet for crops, which with a little labour be converted into a little pond. There are the paddy fields themselves. Above all, there are the innumerable village Ponds, wells and tanks which could be stocked co-operatively by the villagers and even larger numbers of private wells and ponds belonging to individual farmers and land holders. Permanent wells and tanks can be used for breeding and rearing fry for distribution for nonpermanent waters as wellas for growing marketable fish. All waters used for fish culture should be controlled to prevent the entrance of predacious fish and the escape of the cultivated fish. Artificial feeding would probably not be required to any great extent.

Carps are omnivorous and will eat any thing like damaged cereals, kitchen refuse etc., that would otherwise be wasted. In silk producing areas, as in Japan silk worm pupae can be used after the silk has been wound off. In tropical countries, the introduction of suitable vegetation will probably bring in its train, a sufficiency of material for food, while Ponds used for washing cattle, the drainage areas of farms and irrigation waters from cultivated land are likely to be abundantly rich with the tiny organisms upon which the fish feed. Where the water is too shallow and dries up in the hot weather, a little labour may be spent year by year in the slack months in deepening the pond, the mud being removed to the cultivated area to enrich the soil. An occasional crop grown in such a place should yield good results, besides improved fish crop for the following year. The use of sheep droppings or cattle manure, which is available to every farmer will provide an abundance of fish food at no extra cost. A survey of the neighbourhood is likely to reveal plenty of water area which with minimum labour and expense, can be utilised for raising fish.

Suitable fish for rearing.

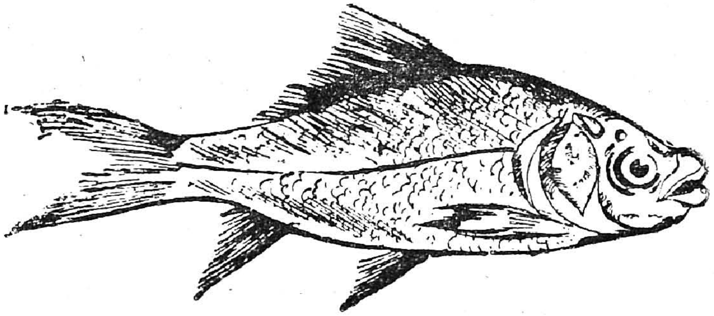
The next question to consider is the availability of suitable fish for rearing. The old stue (small kitchen ponds) of Europe were mainly stocked with carp, and this is the chief fish grown in China, Japan and America now. It is estimated that 60% of the fresh water fish of the Madras presidency at least belong to the carp family and this proportion holds good in other parts of India as well. In the warm waters of tropics this fish

grows at a tremendous rate reaching a marketable size in 3 or 4 months. It also has merit of being hardy and easily reared, while young fry can be transported to considerable distances. The farmer who has only a small temporary pond can therefore, obtain some fry each year with little trouble or expense, at least to supplement the food supply of his family, with the resultant benefit of the general health, while the farmer with larger area of permanent water, can raise his own breeding fish and needs only an initial outlay for good spawners (big fish).

Varieties of fish suitable for rearing in the ponds.

The following fish have been found suitable for cultivation in ponds in the Madras Presidency.

Catla Catla.
Telugu: Botcha or Krishna Botcha;
Tamil: Thoppu Meen.

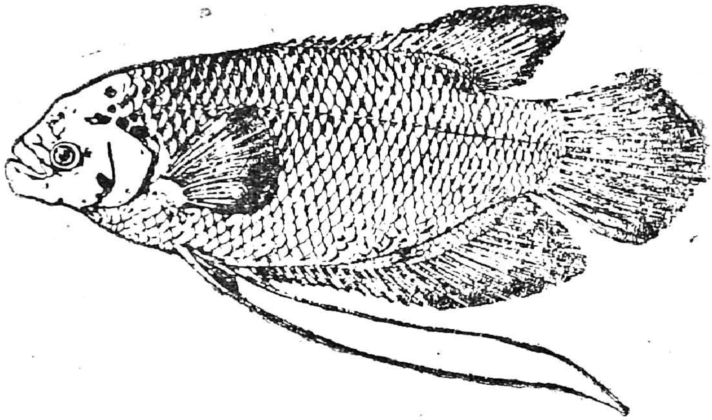


This is a large carp found originally in rivers and tanks north of the Kistna River in the Madras Presidency. It is also found in all the important rivers in Northern India. Since construction of the Cuddapah - Kurnool Canal, it has found its way

into the Pennar River in South India and all its connected tanks. It attains a maximum length of 6 feet with about 140 Lbs, weight; but is usually eaten when not exceeding 2 feet. It is a very hardy fish and can be transported long distances by road or rail. It does not breed in confined waters and therefore, young fish must be collected from the rivers and transferred to ponds. The Madras Fisheries Department is endeavouring to permenantly establish this fish in the tanks and rivers of South India where they are not existing, by annually stocking selected reservoirs and rivers with fingerlings obtained from the Godavari River.

It breeds during the South-West monsoon in rivers. For the best growth, they must be reared in weedy ponds with abundant fresh water snails. Experiments Show that young fish of ½ inch to 1 inch attains on an average length of 1 foot in 6 months and 18 inches to 2 feet in the first year in ponds and wells and the growth is more rapid in perennial water. It is this phenomenal growth which makes Catla a most useful fish for cultivation in non-permanent waters. Catla fingerlings with instructions are supplied to the public by the Department of Madras Fisheries (Asst. Director of Fisheries (Inland), Vepery P. O. Madras) at the cost of Rs. 6-4-0 per 100 exclusive of transport charges during the season (August and September).

Osphromenus Gourami
Tamil : Sangara.
Native of Melanesia.

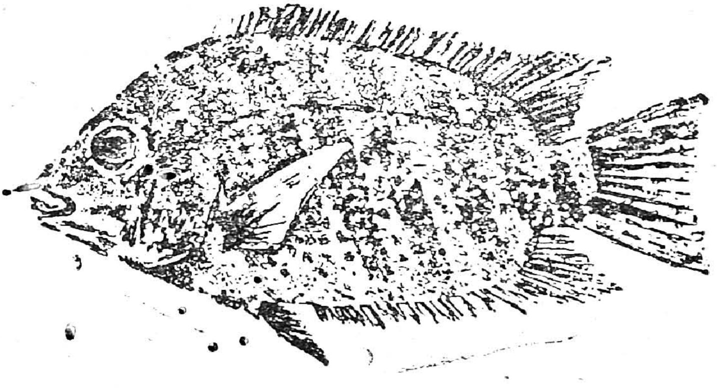


This is the world famous best fresh water fish for the table, and so it is highly esteemed. It was introduced into Madras Presidency from Java and Mauritius in 1916. Its large size, bonelessness and delicate flavour and the ease with which it is bread and transported, render it as the best fish for pisci- culture. This fish is purely a vegetable feeder and breeds twice a year in February and March and again in September to November, building a nest in the weedy margins of the pond. Even tiny small permanent pond with a depth of 3 feet, is admirably suited for them. This fish breeds its best when about 3 years old. Adult fish in breeding ponds may require artificial food. It eats grass, water lillies and other flowering plants with avidity. Adult fish require artificial feeding. Gingely and ground nut oil cakes soacked overnight made into balls and dropped into the ponds once a day will keep the fish well fed. Females aged 6 years and more, generally suffer from fatty degeneration of

the ovaries. They are not prolific breeders; 500 fry per spawner is considered a high maximum in their home water. The fry attains 10 inches in the 2nd year under suitable conditions. They reach only 18 inches in length and attain a weight of 20 lbs., in the course of 3 to 4 years. It breathes air and so travels well over long distances, if consigned in special cans filled with water. Young Gourami fingerlings are supplied by the Fisheries Department, Madras from the fish ponds in Kurnool, Nellore, North Arcot and Chingleput Districts at Rs. 10/- per dozen; stock fish Rs. 9/- and breeders at ~~Rs~~ 22/- per dozen. For Gourmi of course only one initial expenditure is required since the fish breed in confined waters and young fish are available after 3 years in the ponds into which they were introduced. It is not out of the place to mention here that some are of opinion that the cultivation of Gourami is not so very economical when compared to carps. Nevertheless, the cultivation of Gourami as a substitute for marine fish where this is not readily available, is being increasingly undertaken in trapical countries, including India.

ETROPLUS SURATANSIS.

Telugu:- Duvvena chepa Tamil:- Chetha kandi.



This is a back water fish living in brackish or sea water found along in the coasts of Madras Presidency. It readily adopts itself to fresh water and freely breeds in tanks and ponds, 2 to 4 feet deep. Its partial diet is spiro-gyra (hair weed); also takes worms and shrimps. It grows upwards to a foot in length and free of bones and has good flavour. It is also a good sporting fish for anglers. This fish breeds twice a year, but it requires submerged stones or other hard material over the muddy bottom for attaching its eggs. Its growth being slow, cannot be bred and reared to marketable size in ponds or tanks without permanent supply of water. Becomes sexually mature in the 2nd year and breads twice a year from May to June and again from November to February. Spawning maximum is in January. Eggs hatch in 5 days and the larvae when hatched are placed by the parent in a pit closeby. The growth of the young is about 7 inches in the first 6 months and about 1 foot in 2 or 3 years. In 5 years they attain the maximum size and weight 3 lbs.

Fish as food.

Mental and physical efficiency are dependant in the character of food supply and fish may well constitute a needed ingredient which is usually missing from the agriculturist dietory. The requirement of variety in food is unquestionable and the palatability of fish to the average person in connection with its value in protion content, makes it a pleasing and a beneficial addition to the daily requirements. The chemically complex substance known as protein is an essential constituent of food; the most important tissues of the body other than the skeleton, being

primarily composed of it. Most of the human beings derive their needed protein from the flesh of the animals and practically in all civilised countries, the great part of it is supplied by meat and poultry. The shortage of meat supply with the resultant high price is now a general condition. As the substitute for meat, fish offer many advantages. It contains as much protein as meat and in some cases more. It is therefore, comes in the same class as that of beef, mutton and pork. The need is apparent, therefore, in the case of a citizen for a readily accessible supply of fresh fish that may be drawn from the kitchen garden or the poultry yard.

In the commercial report of the Public Health Commissioner with the Government of India, an alarming picture of the increase of population and inadaquacy of food supply was drawn. It is essential, therefore, that the sources of food supply other than agriculture should receive immediate attention.

Importance of fresh water fisheries over marine fisheries.

The fresh water fisheries cover an anormous area comprising water from the highest hill platues down to the sea coast. The most important rivers are the Godavari, Kistna and the Caveri, those rising on the Western ghats and the Nilgiris and numerous perennial streams of other hill ranges in the South India. The majority of rivers emerging on the Eastern Coast, carried during the South West monsoon, a large volume of water to the sea, but during the drier months of the year, the irrigation works or anicuts divert the greater portion of water to meet the demands of the ryots. This

diversion of the water has a most detrimental effect on the fresh water fisheries over certain sections of these rivers on the plains but by protecting the upper reaches where migratory fish breed and the deep gorges which form the fish sanctuaries, the damage could be counteracted.

Taking into consideration 7,50,000 villages in India, (1,50,000 in Madras Province), each having one or two tanks suitable for cultivation of fisheries there is opportunity of producing anormous amount of big and wholesome edible fishes. It is obvious that the number of tanks are increasing every year along with the growing number of houses built, since the bricks for masonry are to be had only by digging out earth. In order to keep these tanks free from unwholesome plants and animals, fishes, mostly of the carp group are usually reared in them. This practice apart from keeping the water pure also keeps a store of fish within an easy reach. The tank fishery has thus a great advantage over the river, estuarine or sea fishery owing to the fact that if taken care of, wholesome fish may be had from them with comparatively little labour and in a very short time. The quantity required may be ascertained before hand and the fishery does not depend on the nature of the tide or the inclemency of the weather. The other problems incidental to the marine fisheries like the trained crew and fishermen, large capital for purchasing craft and tackle like the trawler and the drift nets etc., the methods and the plants required for preservation and the difficulties in the transport problems are in favour of fresh water fisheries including other inland fisheries.

Basic principles for planning the development of Indian fresh water fisheries.

The acute shortage of meat and other animal food chiefly by the unprecedented demand made by the war and the consequent grow more food campaign, we neglected fishing industry as a source of food supply. The urgent need to develop the industry has begun to receive the attention of the concerned. At the instance of Government of India, Provincial and State Governments have set themselves to the task of planning the development of their inland fisheries in the two fold object: 1. of immediate exploitation to meet the present demand; 2. of organising it on scientific lines as a post war national food industry.

For planning the development of Indian fisheries on sound scientific lines expert advice is essential, The Indian fishing industry is too primitive and in the hands of a poor and illiterate class, to produce business men as are available in more advanced countries who could be consulted for planning development. Scientists with academic qualifications practically absent. The greatest obstacle, therefore, is the want of techenical advice and guidence.

The fresh water fisheries of India in the strict sense comprise those of: 1. Rivers and their tributeries; 2. Natural lakes; 3. Artificial reservoirs for irrigation; 4. Canals; 5. Small irrigation tanks; 6. Village ponds.

By far the largest and the most important fisheries are those of Nos. 1 to 4. Of these No. 1 is the

primary source of our best good fishes and it is from the rivers chiefly that all other sources are replenished. From the scientific and economic point of view, therefore, the river requires the first and the most careful attention, if the future of the fisheries is to be safe guarded and their permanent improvement is to be effected.

Plans for developing fresh water fisheries.

Fisheries unlike agriculture or animal husbandy depend primarily upon exploitation of natural, wealth. Fisheries are more akin to Forestry in as much as the collection of natural wealth is concerned. In developing fresh water fisheries therefore, the technical operations involved may be summarised under 3 main heads. 1. Conservation; 2. Culture and 3. Exploitation.

For all the three alike, research and investigation are indispensable. The conservation of fisheries depends on a precise knowledge which is the result of continuous observation on the existing stock of fish, their breeding grounds, seasons and habits etc. The conservany methods usually adopted are: 1. Restriction of mesh and other approved methods of capture 2. Prohibition of whole sale destruction by poisoning or dynamiting; 3. prohibition of capture of young or breeding fish generally; 4. Closure of sections of rivers constituted as sanctuary throughout or for a part of the year. The choice and application of any of these except No. 2 will depend on local conditions.

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CULTURE.

Conservation of the natural resources by itself is insufficient for maximum fish production. Cultural operations - bredding, rearing, stocking etc., through the agency of fish farms are necessary to supplement nature, specially when intensive exploitation is contemplated. Stocking is particularly required for tanks and land locked waters which are likely to be completely fished out. Since rivers are the primary source of supply of indeginous fish, their exploitation beyond the limit of natural recovery must always be watched and prevented. On the other hand, tanks and other land locked waters can be completely fished as the supply can be replenshed by stocking. Even where tanks are fed by river channels, an adequate number of fry of suitable food fishes rarely reaches the tank annually, while invaribly predacious fish obtain access to the tanks. Elimination of predacious variety and ensuring an adequate supply of fry of selected food-fishes, manuring, correcting defects in soil and water and providing abundance supply of weeds and other food for fish are necessary cultural operations if the tanks are to be made to yield to their full quota of fish.

Fish culture is perhaps the most technical and specialised subject of fishery operations. Experience has shown that the fry of indegenous food fishes can be obtained in sufficiently large numbers from suitable areas in the rivers. It is well known that fish are prolific; a million eggs or more are produced by one breeder (carp specially) at one time. This is nature's provision to counteract destruction

by numerous enemies and by an adverse environment. Under natural conditions only a small proportion of the eggs hatch and a much smaller number of the fry survive. If advantage is taken of during the breeding season about this abundance of eggs and fry and are secured and reared in specially designed ponds and stocking tanks, much of the natural wastage in the rivers can be prevented while the high cost of artificial fecundation and hatching of eggs in expensive hatcheries is at the same time avoided. For the indigenous fish like Rohu, Catla, Mrigal etc., therefore, all that is needed, is to provide nursery ponds in suitable places along the rivers; collect the spawn or fry from the river at the proper time and rear them to the fingerling stage for a few weeks and distribute them to tanks and ponds after they received their annual supply of water. Besides indigenous fish, new and imported varieties of food fish have been in introduced and proved a great success in Ceylon, Madras and elsewhere. (Trout, English carp, German carp, Tench, Gourami etc.,). It is perhaps not very well known that even rainbow trout and brook trout have been grown in ponds and Gourami in rivers. Mahseer of the Kunoan hills, have been found to breed in land locked lakes. Another fish which has yielded remarkable results is the carp, (first introduced into Ceylon from Germany and recently introduced into Nilgiries) is a prolific breeder and grows rapidly in the ponds and tanks of hills. The Chinese have probably developed carp culture to perfection. They not only raise carp by intensive feeding with grass (sedges, vallisneria spiralis) and other vegetable matter in ponds but concurrently raise a subsidairy

crop of a different varieties. This type of inteivnse culture has been introduced and practised by Chinese setlers of Malaya and Singapore and should, therefore, worth trying in India. Gourami is another exotic fish which has given satisfactory results in the South while the price is the cheapest. In tropics upto the latitude of Calcutta and Bombay it has been a success; Further north, experiments do not show that Gourami culture is successful.

There are also innumerable technical problems varying with the locality, kinds of fish, climate etc., that require research and investigation before successful piscicultural practice for any problems could be outlined. These investigations relate to the spawning season, breeding habits, character of eggs and fry, rate of growth, the food of the fish at all stages both natural and artificial, the nature of the soil and water and remedial measures for defects in these suitable weeds and pond snails other aquatic life etc. Besides, there are always a number of miscellaneous problems such as wholesale fish mortality which some times occurs, infectious diseases, pollution of water, parasites etc , which should also receive attention. To deal adequately, with all the above problems a central fish farm for research designed on the latest model is necessary. The choice of the site of a fish farm depends on the availability of fry in the river - they can only be obtained from a few places which has to be searched for - good soil, abundant flowing water, good communications, sufficient low lying land to suit the cost of acquistion and the excessive expenditure on excavating ponds.

Exploitation.

It has been shown that river fisheries are of supreme importance to the whole scheme of inland fisheries development and therefore, require to be carefully safeguarded by all adequate conservancy and observation staff. A very large proportion of the fish in the market comes from the rivers giving livelihood to large colonies of river fishermen. The scheme of exploitation therefore, contemplates bringing these fishermen and their operation under the control of the Government to ensure an adequate supply of fish at reasonable rates. At important consuming centres, Government may have launched schems for capture and supply. In most provinces and states, Government being the largest owner of the fisheries, if the trade is incapable of immediate improvement and co-operative agencies cannot be organised, Government will have to initiate fishing and marketing themselves without having any intention of eliminating the trader or the fish monger wholesale, a model shop at important centres with fixed prices is all that should be run by Government to stabilise prices and to enforce reforms in hygine and proper handling of fish.

Exploitation involves capture, handling, preservation, transport, disposal of waste and manufacture of by-products, all of which it will be the duty of the marketing staff to develop with the assistants of the technical staff of the fisheries-organisation. Experience has shown that great deal can be done for improving the indigenous catching methods. Flood rivers, deep and perinniel tanks, go practically

unfished as fishermen generally lack efficient craft and tackle, proper dressings, adequate refrigeration and rapid transport, or other new reforms which have already given satisfactory results and could be expanded on country-wide scale. Although there may not be any surplus and nearly all fish will be sold fresh, it is possible to utilise fish offal and waste resulting from the dressing of fish for conversion into manure, fish meals or oils while the abundant supply of small fish at dams as well as Hisla might afford facilities for canning on small scale. Model nets and boats, a refrigeration plant, and model apparatus for trying of experiments in canning, curing, smoking, extraction of oils, manufacture of manure and meals have to be provided for in the estimate for the technological laboratory.

All the operations need specially trained and thoroughly qualified staff.

The Reconstruction Committee (Postwar Planning) has made the following recommendation with regard to Fisheries.

"Fish is an important article of diet but at present only an insignificant proportion of the country's food supply is contributed by her fisheries. Indian fisheries can be developed to a very considerable extent if the main restrictive factors are removed.

Apart from research and experimental work on the problems of fisheries, and in addition to the surveys which must be undertaken with a view to collecting information on the basis of which large scale projects for development can be prepared (by the Central Government), arrangements should be

made for the Fisheries Departments in the Provinces and States, so that by working in close co-operation (with the Central Government), these Departments can carry out complementary research and surveys, prepare plans of development and execute them. Simultaueously with this, small projects for development should also be taken up in hand. The preparation and execution of these small projects, will provide useful information for undertaking further development. They would fall under the following main heads:—

(a) Development of the supply of fry for stocking fresh water ponds, canals, tanks etc.

(b) Location of breeding areas for the various types of fresh water fish and protection thereof.

(c) Development of the practice of breeding fish in inpounded water (whether used for irrigation or otherwise) and for the distribution and sale of the produce in markets within easy reach.

(d) Development of the cold storage accommodation at the collecting and consuming centres and cold storage transport from collecting centres to consuming centres.

(e) Development of air-transport or other means of quick transport for fish from collecting centres to consuming centres.

(f) Development of the industry related to the preservation of fish by canning, pickling smoking, de-hidration, etc.

(g) Experiments with different designs of fishing

crafts and equipment in respect of both inland and marine fisheries.

(h) Development of the fish oil industry.

(i) Schemes for the protection of fish from excessive or improper exploitation."

Economical value of carp culture.

In Bavaria where the farmers grow crops of cereals and of fish mostly carps, along side on one another, *it is fully realised that the carp ponds are more profitable than an equal area of good land.* The details of economics of carp culture in Europe are furnished by Joseph Susta, K. G. Gupta and Sir F. A. Nicholson. It has been estimated by Nichalson that in Germany, the average net profit varies from Rs. 27-8-0 to Rs. 60/- per acre per crop and this is obtained with certainity and minimum of trouble.

Rough calculation per acre.

Fry costing Rs. 50/-. Transporting charges will Rs. 100/-. So, for 1,000/- carps Rs. 150/- are necessary. Then there are charges for preparing the tank. dewatering, desilting etc. Half a dozen nymphia etc., is enough per acre. Another Rs. 150/- might be for this expenditure. Rs. 100/- for unforseen expenditure. Altogether, Rs. 500/- will be the expenses at the most. If all the stock is carefully fed, it might fetch, Rs. 1,000/- minimum in the year. So, in the year, Rs. 500/- is reasonable to expect per acre. Rs, 60/- per month is the modest expectation.

The results both in gross out turn and net profits are considerable. The balance sheets including all charges, cost of manure etc., show a very

useful net profit, which is surprising when the waste and wretched nature of the land is considered. C. V. Hall dealing with the commercial aspects and revenue from the culture of fish in ponds, made the following observations based on his continental experience where carp is highly esteemed.

One must take into consideration the fact that fish cultivation requires less labour and out lay than agriculture and it is not dependent on the agriculrists' great bugbear: the changes of whether. Good carp ponds will produce from 150 to 250 lbs., of marketable fish per acre annually; the average prices are wholesale ~~Rs.~~ 1/- per fish and retail Rs. 1-8-0 to Rs. 2/- per pound is reasonable expectation. Live fish command better prices.

The carps of tropical countries are usually larger and grow far more quicker than those in the temperate countries. Thomas stocked a rain fed pond of some 3 to 5 acres of water spread at Vallam in the Tanjore District with about 2 lbs., weight of well selected fry of non-predatery fish at a cost of Rs. 2/-. The tank had run dry before the rains and was cleared of all the predatory fishes. A handful of small snails were also put into the tank as food for the fishes and fishing was prohibitted for 18 months. After this the tank was thrown open for fishing with rod and line and was found that anglers were taking fish out of that pond with a rate amounted to 4,000 lbs. weight of fish a year. As time went on, anglers grew in numbers, than otherwise and some of them took to it, not as a past time but as a profession selling their catches and as the fishes grew bigger, they started country

made reels and running line as Mr. Thomas taught them and always looked at him with a pleased smile as he strolled round to ask what sport and looked at their bag; and after more than year, had passed they declared that not only had all the fishing made no impression on the fish, but total takes were continuing to increase. As there was no netting and only angling, he let them fish all the year round without any close time. From these observations, Thomas concluded that 2 lbs, weight of fry yielded after 18 months, 4,000 lbs, weight a year and subsequent years, yielded a much greater result. He arributed this success for eradication of predatory fish from the tank, careful selection of fry introduction of species that more or less feed differently. Further, he observed that some Labeos introduced by him in the tank had bread in it with result that when these fish began to multiply the total weight of the tank increased very much. On the basis of the rate of growth of Catla, Mrigal, observed in the tank in Chinsura (Bengal), on the assumption that 1,000 fingerlings were stocked in a tank, not exceeding an acre in extent, only 500 survived by the end of the 2nd year. Gupta made the following calculation.

Debit.		*Credit*	
1,000 fry..........	Rs. 15/-	Value of 750 seers of fish @ 0/4/0 a seer	Rs. 190/-
Payment to fishermen	Rs. 30/-	Deduction of expenses........	Rs. 50/-
Miscellaneons...	Rs. 5/-		
Total value......	Rs. 50/-	Net profit	Rs. 140/-

Gupta regarded this below estimate which is often exceeded that. If the tank is regularly stocked every year, a clear profit of 100 to 200 rupees per anum may be ensured and that with a minimum expenditure of money and trouble. *According to Moses, one acre of suitable area is computed to have easily produced 1,000 Lbs of fish annually.* S. B. Satna, fisheries officer, Bengal, has been conducting experiments in carp culture in sheets of water which dry up annually and have therefore, to be restocked after having harvested every year. In the Kurla tank, 4½ acres in extent, he introduced 2,000 carp fry from Patna at a cost of Rs 28-2-0 and after 9½ months the fishing rights were auctioned to 321/- rupees. This tank was again stocked on 7th July with 3,000 fry at a cost of 59-12-0 (Rs. 9-12-0 fry and Rs. 50/- transport charges from Patna to Bombay including III Class ticket for the attendant). This tank was auctioned for a party for Rs. 400/- who sold to a third party to Rs. 450/-. In another tank, Bundra Tank, 1½ acres in area, 3000 carp fry at a cost of about Rs. 50/- were introduced in 1940 and 1941, after a period of 6 months, 250 Rohu and catla from this tank were liberated into the Ulhas River and the remaining 1,600 approximately weighing 11,00 Lbs. were sold at cost of 144-12-0. In the Thana Jail Tank, 5 acres in area 2000 fry at a total cost of Rs. 38/- were stocked and after 7 months its fishing rights were auctioned for Rs. 315/-. Several other tanks showed more or less similar results. In considering the above date, it must borne in mind that the fish were to be taken out after a period of 6 to 9 months. No manuring of the ponds was done before the fish were stocked and no artificial

food was given to the fish. The above results should not be calculated on acrage basis as the tanks were not stocked according to their full capacity. Further on the expenditure side, it must be remembered that the fry were obtained from Patna and their cost of transport to Bombay was fairly heavy. In cases where local supply can be arranged the cost of stoking the tanks will be considerably less. In connection with the above experiments, Setna wrote to say "Experience shows that the best results are obtained when the mixed fry contain preponderance of Catla and Rohu (Rohu beats Catla in taste). These fry grow rapidly and thus yield lucrative retnrns. The fry obtained from Patna and other centres are mixed and this is the reason why the returns are variable. They fry of Mrigal and Calbasu which some times figure very largely in consignments do not yield satisfactory results. These fish take long to grow and are not profitable from Commercial point of view.

It will thus be seen, that the stocking of tanks with selected fry is highly desirable from a commercial stand point. The success of Thomas's experiment reported above was also due very largely to this fact. As regard the rate of growth of fish, the figures for 2 tanks mentioned by Setna are given below. The fry when introduced were one inch in length. Kurla tank stocked on 7-8-39, fished on 25-5-40 after 9 months and 17 days.

Species.	Total length.	Standard length.	Girth.	Weight.
Catla.	22½"	18½"	19 "	18lbs.
Rohu.	17½"	14½"	10½"	2¾lbs.
Mrigal.	16 "	13 "	8½"	1¾Lbs.

Bandra Tank.

Catla.	16 "	13"	13½"	3½ Lbs.
Rohu.	13½"	11"	9¾"	10½ Lbs.
Mrigal.	9½"	8"	7 "	¾ Lbs.

From the details given in the above table the growth of 1 Lb. seems to be very satisfactory. In Madras waters, a growth of 1 Lb. in 70 days is on record. In the case of Catla, Moses had stated, that it attains a marketable size in 6 months and weight of 24 Lbs. in 2 Yrs. and 40 Lbs. in 3 years. Satna's figures clearly indicate the possibility of such a rapid growth.

Seasonal ponds

The ponds that dry up annually show remarkably good results, with regard to the growth of fishes. In the annual fisheries of the Bidhyadhari Spill Area near Calcutta, very good results are obtained through manuring them with diluted sewage. Some of these vast sheets of water are dewatered annually for paddy cultivation and some for the improvement of fisheries, but the rapid growth of carp is mainly due to the proper manuring of tank. The productivity of Bidhyadhari is usually 2½ maunds of fish for Biga annually (40 yards into 40 yards). Besides the crop of fishes in ponds of the fishery, a crop of paddy is also harvested. In the areas of sunderbunds where ideal conditions exist for fish growth, Catla and Rohu are known to attain 6 to 7 seers in weight in one season. It is thus clear that in carp culture very bright prospects lie before an intelligent pisciculturist, who begins to apply up-to-date scientific methods for the care of the pond and the production of the fish crop.

Perennial ponds.

In the case of tanks which do not dry up annually, it is highly desirable not to take out the fish at the end of the first season for the growth of Rohu, Catla and Mrigal is much pronounced in the 2nd and 3rd years of their lives. It is stated by Dale that "Fishing rent of the tanks in the marshes of the hill country in Faridpur, when leased for 2 years is 3 to 4 times of the rent of the lease for one year. For fish productivity therefore, it is necessary to lease out fisheries for 5 to 10 years after which the tank should be dried and its bed should be properly manured before leasing it out again. The usual term of one year's lease is highly detrimental to prisciculture as the production is ¼ or so that what it would have been even in a 2 years' lease.

Stocking perennnial pond should be done annually and fishing should commence from the 3rd year – to repeat every year. In that case the 1st year's stock will reach profitable stage by 3rd year and the 2nd years' stock will do so in 4th and the 3rd year's stock to the 5th year and so on."

The following information is essential to a pisciculturist.

1. Which of the several kinds of fresh water food fish available in this presidency are suitable for stocking in wells and ponds?

2. What is the breeding season of the selected fishes and when the young fish can be obtained plentifully and cheaply for stocking wells and ponds?

3. Are suitable fish for pisciculture available locally, if not the nearest source from where they can be obtained and the cheapest method of transport?

4. What is the favourable food for these fishes and how such food (natural and artificial) to be obtained abundantly and cheaply?

5. What weeds, snails and other vegetable and animal organisms are associated with the occurance and the abundance of these and how could they be cultivated in ponds and wells?

6. What are the favourable physical and chemical characteristics of waters in which different fish thrive best and how to remedy unfavourable conditions present in certain wells and ponds?

7. What are the enemies of fish and how to eradicate them in ponds and wells for successful results?

8. What are the diseases of fish in captivity?

Inland Fish Farming.

CHAPTER II.

Classification and Identification of Fishes.

In the world all things are divided into two kinds: viz. Animate and inanimate. Animate groups are sub-divided into animals and plants and thus the study of animates comes into Biology and Botony. Small animals which are not visible to the naked eye come under protozoa. Animals in their turn are classified into two kinds: vertebrates and invertebrates and the fish is defined as a vertebrate cold blooded animal adopted to aquatic life having extremities modified into fins; respiring solely by means of gills, possessing a heart with one or two cavities. The scales of a fish are sometimes in the form of possession plates.

The fins are one of the most important parts of fish in identifying to which variety it belonged. They are classified into two categories (1) Fins in pairs and vertical fins. Paired fins are usually situated on the sides of the fish-such as ventral and pectoral fins. Vertical fins are such as dorsal and caudal fins which are situated on the back and extremity of the fish. Fins are of several varieties: soft or spinous or of adipose growth. The paired fins that are in the front, one on each side of the body are called pectoral fins and the pair of fins just below the pectoral fins are termed as ventral fins. The fin on the back of the fish is called dorsal fin and in some varieties of fishes, there are two dorsal fins. The fin at the tail is called caudal and the anal fin is situated on the abdomen of the fish

nearer to the caudal fin. Usually the fins of a fish are of not great value in its movement and they serve solely for balancing its body in the water. The fins consists of spines and rays. The rays are articulated or branched out and the spines are not. In classifying fishes, the spines and rays in each fin are counted and expressed. For example if the dorsal fin of a fish consists of 2 to 3 spines and 9 to 10 rays, it is express as D II-III/9-10. When there are two dorsal fins, the description will be indicated as D1 II-III/9-10; D2. I/10-11. This denotes the first dorsal fin is having two to three spines and 9 to 10 rays and the 2nd dorsal fin is having one spine and ten to 11 rays. The spines may be indicated by Roman Fingures and the rays by Arabic. Likewise, all other fins are described by denoting the first letter of the word and mentioning the number of spines and rays afterwards. Thus if the fish Cirrhina cirrhosa (Tella Gandu Meenu in Telugu) is described as BIII; D 17 to 19 (3 to 4/14 to 18); P 19; V 9; A 8 (3/5); C 19: Ll. 42 to 44; Ltr. 8/9, it means- BIII means that there are three Branchiostegal Rays.

Branchoistegal Rays.

Gill-covers are situated below the mouth at the sides of the head of the fish. There will be a continous fringe along the margin of the gill cover and this fringe is supported by bony rays called Branchiostegal rays. In describing the fish, these Branchiostegal rays are counted and expressed in Roman numerals.

D 17 to 19 (3 to 4/14 to 15) means that the dorsal fin has 17 to 19 rays of which 3 to 4 are

spines and 14 to 15 rays. P 19 and V 9 means that there are 19 rays in the pectoral fin and 9 rays in the ventral fin. A 8 (3/5) means that the Anal fin consists of 8 rays of which 3 are spines and 5 are rays. C 19. means Caudal fin has 19 rays.

L1 42 to 44.- means.—

In most of the fishes there will be a series of perforated scales running in a line along each side from head to tail. These scales have pores connected to sensory cells by which the fish feels the differences in the pressure of water currents. This line of scales is lateral line and it is represented as L1 in describing the fish. The scales in the line from head to the base of the tail are counted and denoted. Thus here L1 42 to 44 means that there are 42 to 44 scales along the lateral line from the head to base of the tail of the fish.

Ltr. 8/9 means:— Ltr. is the abreviation to lateral transverse and the number of scales on the transverse row between the middle line of the back to the abdomen are counted. These scales above and below the leteral line are counted separately and indicated. Thus Ltr. 8/9 means that there are 8 scales above the lateral line and 9 scales below it along the lateral transverse line. Usually these scales are counted just upto the dorsal fin above the lateral line and upto the base of the ventral fin below the lateral line.

Measurements of fishes.

The total length of the fish is from its tip of the snout to the end the tail fin. Length of the body is measured from the tip of the snout to the

base of the tail fin. The last scales which overlap the base of the caudal fin need not be also measured. The perpendicular line through the body at its deepest part of the fish is taken as the depth of the fish. In identifying a fish, the relative lengths of various parts of the body are also indicated.

Weight of fishes.

Weight of fishes. The following is the general formula in estimating the weight of the fishes:—

Measure the length and girth of the fish in inches. Multiply 1¼ of the lengh of the fish by the square of its girth and divide it by 1,000. The result will be the weight of the fish in pounds. $(L'' - \frac{1}{4}L'') \times (G'')^2$ = weight in pounds. L is the length in inches from tip of snout to the fork of tail and G is the greatest girth in inches.

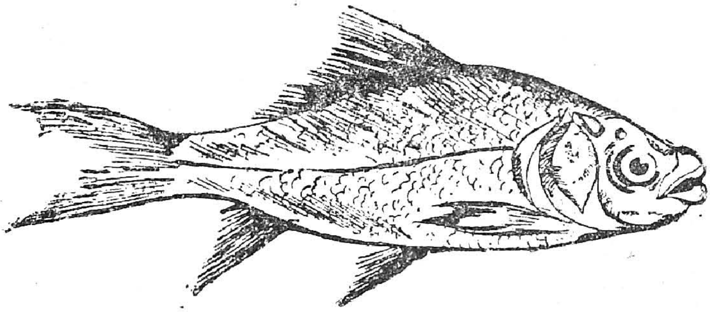
Common Classification of fiish:—

CYPRINIDAE.

The fishes generally known as 'Carps' consitute the largest group among the Indian freshwater fishes and belong to the Cyprinidae family. The carps are defined as scaly fish with pharyangeal teeth and having single spinless dorsal fins, habitated in fresh waters. (Pharyngeal Teeth:- Behind the gills at the opening of the gullet, are some round fins armed with sharp thick teeth called pharyngeal teeth. They are fixed with the throat,

CATLA CATLA.

(Telugu: Botchu or Kistna Botchu; Tamil: Thoppu Meen).



B III. D. 17-19 (3-4/14-16). P. 21. V. 9; A. 8 (3/5); C. 19; L1. 40-43; Ltr. 7½/9.

With the exception of the Mahseer found only in hill streams, this is the largest carp in India.

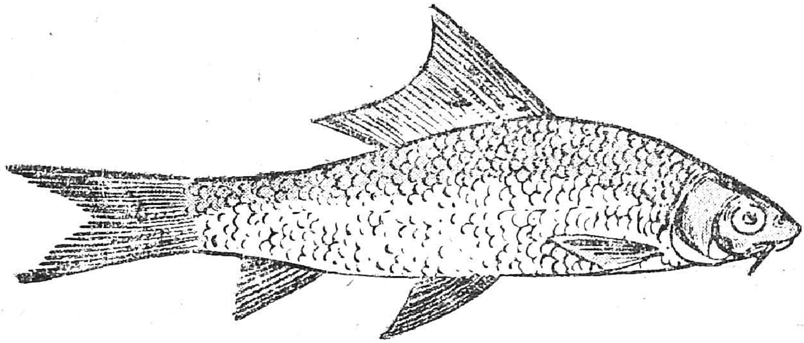
Head broad, upper lip absent, lower moderately thick having continuous and free posterior margin. No barbels; eyes with 3 orbital margins. Dorsal fin rather long without osseous ray. Mouth vide, lower jaw prominent. In large specimen, some pores on the snout are visible; colour greyish above, becoming silvery on the sides and beneath. Fins dark coloured in some specimens, nearly black (Kaki Botchu). Breeds in river during monsoon. Does not breed in confined waters except in bundh type of tanks. Quickly grown spawn and larve can be collected in mosquito net, funnel shaped nets

set up in shallow and sheltered areas especially on the margins of the islands in the river in the lower reaches, where the velocity of the water is at a minimum. Fry and fingerlings are collected in paddy fields in deltaic regions, in the close meshed basket traps or 'Mavulu' (in Telugu). Some young fingerlings are black and some are white, the colour varying with ecological conditions. The black ones are known in delta areas as 'Kaki Botchu' (Telugu). It is not a different species or variety but only the colour of the fish. This fish is largely employed for stocking tanks, since it does not breed in them, stock is obtained anually from the natural sources for stocking purposes. In May, 1875, Mr. Mitchels had a tank 65' X 55' X13' and other ponds and ground at Calcutta and in it were put some fry of these species from ½" to 1" or less in length. On 22nd Sept., the tank was netted and several dozens captured. One of the largest weighing 14 ozs., and measuring 11 inches in length. Others were 1 or 2 ozs.

HABITATION.-- Throughout India down to Krishna river. Not known to occur in the South down to Krishna. Introduced to South in Cauvery since 1922. Attains atleast 6 feet in length and is much esteemed as food when not exceeding 2 feet in length; larger ones are coarse. It resides in fresh or brackish water being found within tidal influence. It is very strong and active fish and aften leaps over the net.

CIRRHINA CIRRHOSA.

(Telugu: Thella Gandu Meenu; Vengadu in Tamil; English: White Carp).



B III. D. 17-19 (3-4/14-15); P. 19 V. 9; A. 8 (3/5); C. 19; Ll. 42 - 44; Ltr. 8/9.

This is an elegant fish having brilliant colours in gold and bronze. Good for table and very active. First ray of the dorsal fin elongated. Orange scales scattered over the body. Flesh flabby. Mouth inferior - bottom feeder. Eyes with yellow ring. Usually some fine pores are found on the snout which do not project beyond the jaws. Barbels - rostral longer than the maxillery. Fins: Dorsal is as high as the body arising considerably in advance of the ventrals upper margin concave. In some large specimens, the first few rays are very elongated. Males are said to have got this characteristic of having first long dorsal fin. Colour silvery; every scale dotted in the centre except on the abdomen where they are yellowish. Dorsal and caudal stained with grey. Obtained in Godavari, Kistna and Cauvery rivers. Grows to 1½ feet in length. A very active fish. Best for eating - bony and

cheapest. The fingerlings have a tendency to jump and difficult to condition. There will be mortality in transport. Collected in bascket traps in Godavari paddy fields and are called, Chitra Gandumeenu,. These can take the place of Mrigal of Bengal. (C. cirrhosa grows upto 1½ feet and Mrigal upto 3 ft.). To prevent fingerlings being hurt during conditioning, a diaphrugm of netting or mosquito netting cloth may be provided inside the conditioning boxes or the tin carriers.

CIRRHINA - MRIGALA.

B III; D. 15-16 (3/12 - 13); P. 15; V. 9; A. 8 (3/5); C. 15; Ll. 40 - 45; Ltr. 6½ - 7/8½.

This is a native of Bengal Province and was introduced into the Madras Presidency in the year 1943. This differes from the White carp in having 2 barbels instead of 4. This is a bottom feeder and very good for stocking tanks. This grows to 3 feet in length, and good for table. Pores may be present or absent from the mouth. Colour silvery, dark grey along the back sometimes having a coppery tinge. Dorsal, Poctoral and Anal fins are orange stained with black; eyes golden.

CIRRHINA REBA.

(Telugu: Moju or Aruju or Chitra; Tamil: Pillaranja or Thataranja.)

B III; D-10 to 11; (2/8 to 9); P. 16; V 9; A. 8. (3/5); C. 19; Ll. 35 to 38; Ltr 7/9.

Barbles - short rostral, which may be absent. None on maxila. Scales hexogonal. Colour:

silvery, scales generally darkest at their edges forming bluish longitudinal bands above the lateral lines. The young have some times a leaden coloured band along the side or even a black tip to the dorsal fin. Attains a foot in length like Barbus sarana. (This is considered to be of secondary importance where other good varieties are available.

CYPRINUS CARPIO.

(Mirror carp).

This is a cold water fish reared at OOTY. There are three varieties in this: (1) Leather Carp, without scales or one or two scattered along the lateral line; (2) Mirror carp, with very big scales with reflective power as glass pieces; (3) Scaly carp, with small scales all over the body.

Originally Chinese Carp taken to Prussia from where it was brought to Ceylon and thence to Nilgiris. Leather Carp is the highest evolution in Carp by experiments. It lives on and above 4,000 feet and it is cold water fish. This was introduced in the Cresent Pond, Government Botanical Gardens, Ooty in January, 1939. It breeds in its 3rd year during cold months and it is a prolific breeder. The young ones stand transport well. Thick growth of water weeds like water lillies, eel grass, Aponogeton (cold water plant) are suitable for Mirror Carp pond. Generally it uproots the plants and feeds on the insect life harboured in the fibrus root clusters. It is very good game fish. Experiments to introduce in lower altitudes even to the sea level have been successful; but there is no evidence that the fish can breed here. If avliable it takes carnivorous food.

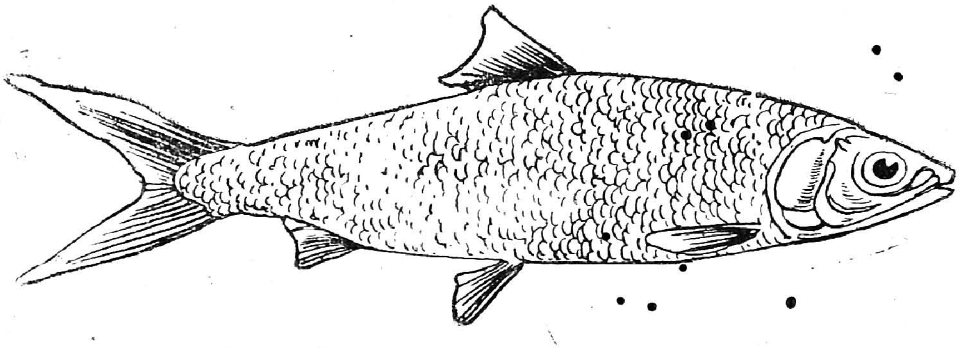
RAINBOW TROUT.

Caught in Mukurti Lake - in Nilgiris. It belongs to the family of solmon, cold water or hill fish brought to India from England aud Newzealand. The two important species introduced into India are 1. Salmo Fario (Brown trout) found in the Kashmer Hill range. It requires very low temperature. The second is Salmo irridus or Rainbow trout. This requires a higher temperature than the brown trout introduced in the Nilgiri water. This is the aristocrate of the game fish. Carnivorous in diet, living on insects and files (draggon fly and May fly) artificially fed on dog fish made of wheat, beef or backon. It got its name from the rainbow colours on its sides.

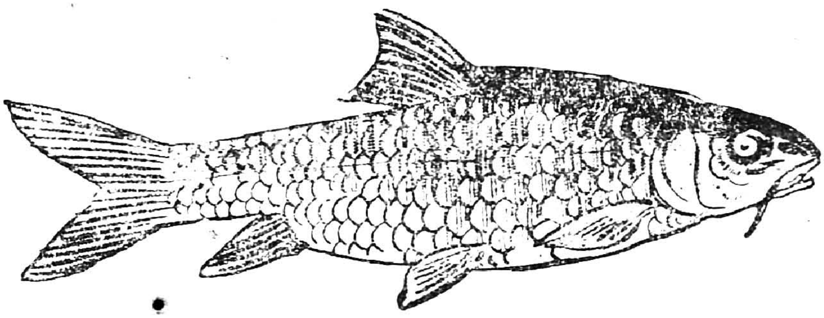
The dorsal portion and the whole caudal fin are dotted. It has got an adipose fin (near caudal) fin on the back. Generally it is caught on an artificial food, baits like flies and spoon etc., Dead bait is prohibited since it is not sportive and it will contaminate the clear trout water (Ooty trout farm).

BIRILIUS BOLA.

(Indian trout).



D. 10–11; A. 13 L1 88 – 94. Blotches in two rows on the lateral; without barbels. A deep cleft in the snout which is pointed. Silvery in colour with spots in rows. Dorsal fin is greyish at the bottom. Pectoral, Ventral and Anal and Caudal fins are orange coloured stained grey and black at the bases. Good for table and game. Thrives well in high altitudes and takes fly very well.



BORBUS TOR.

(Tamil: Bommi. No particular Telugu name available)

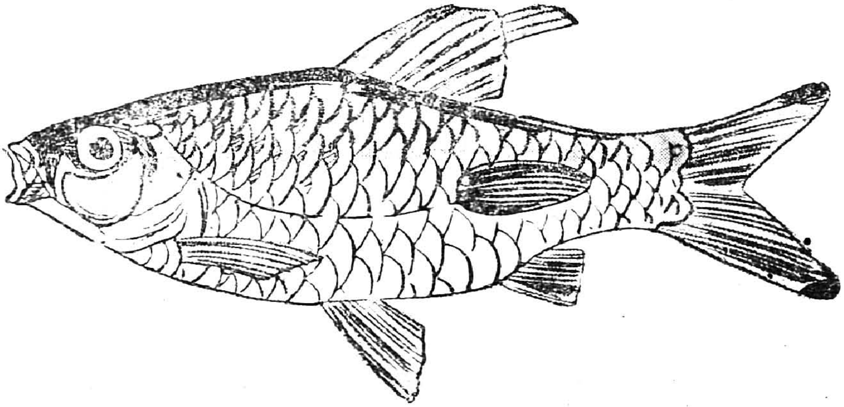
B III.; D. 12 (3/9); P. 19; V. 9; A. 7 – 8 (2 to 3/5); L1. 25 to 27; Ltr. 4/4. 4 Barbels.

The maxillery pair longer than the rostral and extending below the last third of the eye. Lips lobed or fringed.

Colour:— Silvery or greenish along the upper part of the body becoming silvery or shot with gold on the sides and beneath; lower fins reddish yellow. The colouration varies in different localities and even in the same locality. Deep golden, light-silvery, distinctly blue, dark and even black are the various colours.

This is called the celebrated Mahseer of the sportsmen of India. Breeds in the upper reaches of rivers on the gravel and small stones in tributory streams and in very shallow waters. The fish first scoops out of the gravel and stone from the bottom of the river for the reception of eggs. They are generally found throughout India, but the largest size and greatest number are found in mountain streams or those which are rocky.

Barbus filamentosus Black spot.



B. III; D. 11 (3/8); P. 15; V. 9; A. 7 (2/5); C. 19
L1. 21; Ltr. 4/4.

This has no barbels and comes under group of small fishes that are common. Colour silvery, each scale having green edge. The caudal fin is red tipped with black spots. It has an oval black mark on the leteral line near the caudal. The whole body assumes scarlet colour immediately after death. This is good for table and can be well be reared in tanks and still waters. Breeds in

December and attains 6 inches in length. Biggest carp but because of its predacious nature, it is not recommended for pond culture. It is tasty, grows more than 6 feet in length. It will be found in the mountain streams which flow with a considerable force. It is more of a spindle shape with an inferior mouth. As it is a hunter, it goes to all columns of water; but as a rule, it is a bottom feeder. It is said that no particular fish can claim the name of Mahseer. Naturalists are reported to have given this name to the biggest fish of the tribe - Borbus tor and the locals calling any larger fish of predatory barbels of the family of Barbus as Mahseer. In duccan this fish is said to be called as Mahasala.

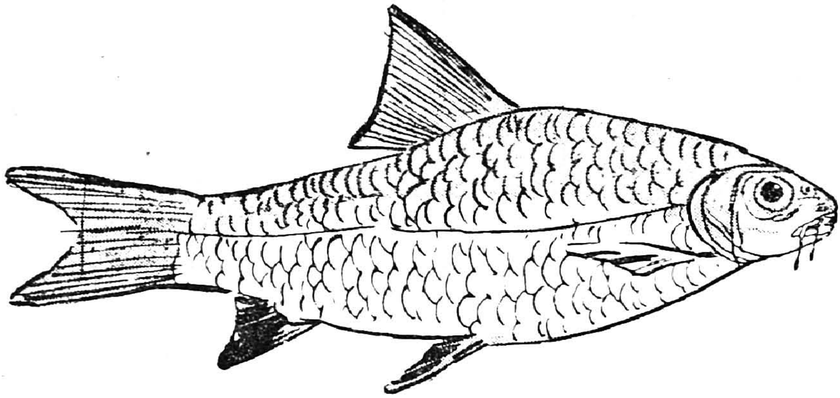
Barbus Dubius.

Telugu: Kodi chepa; Tamil: Kodi meen.

B. III; D. 13 (4/9); P. 17; V. 9; A. 7 (2/5); Ll. 42 to 45; Ltr. 9/8.

Colour:— Uniform silvery with the bases of the scales darker. Cauvery specimens are very brilliantly coloured with blue cheeks and head and mouth red. Tubercles present. Attains to about 2 feet in length. Eggs are supposed to be poisonous and cause severe diarrhoae. Can be reared in ponds.

Barbus Carnaticus. Tamil: Paviri.



B. III, D. 12 (4/8); P/15; V. 9; A. 7; C. 19; L1. 32; Ltr. 5/6.

Barbels thin, both pairs shorter than the eye. Colour greenish brown alongback, becoming dull white glossed with gold on the sides and beneath. Fins greyish; eyes golden; attains at least 25 lbs., in weight. Takes fly well and can be caught on leaf also. Tasty and can be reared in ponds. This is a bottom feeder. Spawns September to November. Aquatic weeds, grass are liked much by this fish.

Barbus Carmuca. (White carp).

B. III. D. 12 (3/9); P. 16; V. 9; A. 8 (3/5); C. 18. L1. 41; Ltr. 8/7.

Colour:— Bright silvery becoming lighter on the sides and underneath, the tips of the caudal fin stained black. The back is more curved and convex than the base. Maxillary barbels are in two

pairs the lower reaching the eye and the upper half of it. In the young fish, the middle of the third of the caudal is orange tipped with black. This attains 4 feet in length.

Barbus Sarana – [Olive carp].

B. III; D. 11 (3/8); P. 15; V. 9; A. 8 (3/5); C. 19; L1. 32 to 34; Ltr. 5½ to 6/6.

There is another species in this called Barbus chrysopoma. Difference is B III. D, 12 (4/8); P. 17; V. 9; A. 8 (3/5); C. 19; L1. 28 to 30; Ltr. 6/6. The other particulars agree. Dorsal one more and pectoral two more. Colour almost the same. Colour of B. Sarana is silvery, darkest superiorly, opercles shot with gold. The young have occasionally a dull blotch on the lateral line before the rays of caudal fin and some dark spots behind the opercle. When the fish is fresh, there are some times horizontal lines along the rows of scales in the upper half of the body. Fins whitish or yellowish white and externally stained with grey. Grows upto 2½ feet in length.

Barbus Chrysepoma.

Telugu: Kannaku; Tamil: Pakki or Shanikandai.

Colour dark silvery, becoming lighter beneath; opercle shot with purple and gold. A dark vertical band behind the opercles and dull spot on the lateral line just anterior to the base of the caudal fin. Upper and lower margins of the caudal fin are grayish and other fins are golden. Eyes larger than that of sarana. Usually kept in tanks and ponds of temples. Attains about 3 feet in length.

Barbus hexagonolepis. (Chocolate Mahseer)

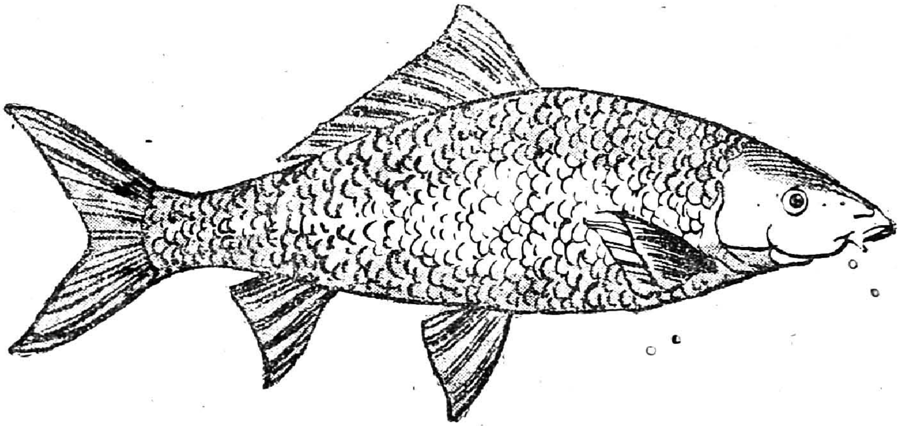
B. III; D 4/9; P. 1/13-15; V. 1/8; A. 3/5; C. 19; Ll. 22-31; Ltr. $4\frac{1}{2}$X$4\frac{1}{2}$.

The scales of this fish are 6 sided (hexogonal). Said to attain more than 2 feet. It has got beautiful colours which vary according to the water in which it inhabitates. The features of this fish coincide with that of B. tor. Several rows of horny tubercles exist on the sides and below the eyes. Barbles - maxillery, reach nearly below the hind edge of the pre-opercle (gill edge). The rostral is shorter. A very good fish for sport and table. Omnivorous and not suited to be reared in ponds along with the other species.

Labeo Group.

LABEO CALBASU.

(Labeo calbasu). Kalbasu and Kunda in Bengali, Kala benies in Hindi, Telugu: Kaki Gandu Meenu; or Nalla Gandu Meenu; Tamil: Kaka Meen.

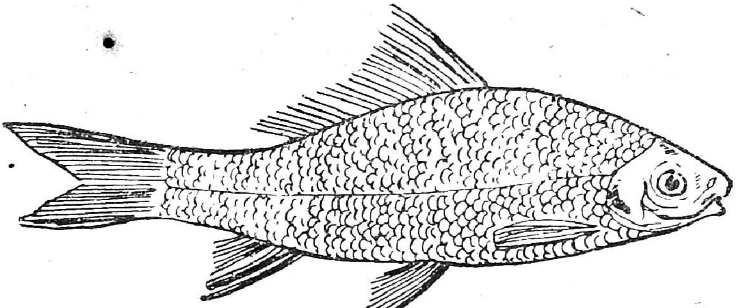


B. III. D. 16 to 18 (3/13-15); P. 9; V. 9; A. 7; (2/5); C. 19; Ll. 40-44.

Colour blackish, some times scarlet centres on the scales occur. Fins black; occasionally the end of the upper lobe of caudal white; barbles 4; grows 4 feet in length; good for culture and table. Hard, stands transport well. Obtained in abundance in Godavari, Kistna and Cauvary. Bottom feeder. Aquatic weeds and minute crustacea are its food. They do very well in tanks, and said to have got partiality for old masonry, walls and sunken trees in rivers and can be seen playing about in such places, sucking and rubbing their sides against the objects.

Labeo Fimbriatus,

Telugu: Erra Gandu Meenu; Tamil: Sel.



B. III; D. 19 to 22; (4/15 to 18); P. 17; V. 9; A 7; (2/5); C. 19; Ll. 44 to 47; Ltr. 9 to 10/8 - 9;

Four barbles. Barbles rostral and maxillery pairs short. Colour silvery along the back, becoming lighter on the sides and beneath. Fins stained with black. A dark blotch present on the end at the base of the caudal; breeds in confined water and hence most suitable for pond culture; hardy and stands transport well; brouses on stones

and a bottom feeder, goes to mid-column as well. Lips thick and continuous having an inner fold above and below both fringes. Mouth slightly overhung by the snout and studded with minute pores. Grows more than 1½ feet and good for table. Eel grass, Vellesneria spiralis etc., are the food.

Labeo Negrescens.

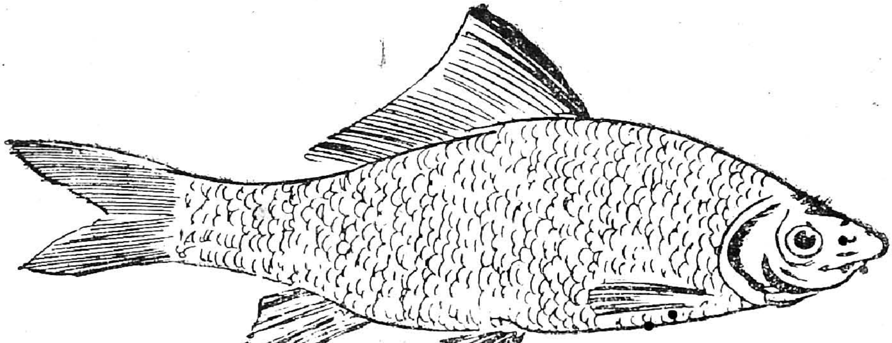
Telugu: Paralu.

B. III; D. 17 to 18 (3/14 to 15); P. 19; A. 7; (2/5); C. 19 to 21; Ll. 36; Ltr. 6/7.

Barbles maxillery and rostral; colour deep brown and varies according to locality. Attains 1½ feet in length and good for table and culture. Common in Godavari, Kistna and Cauvary.

Labeo Rohita.

Oria: Rohu; Bengali: Kuee.



B. III; D. 15-16 (3/12 - 13); P. 17; V. 9; A. 7 (2/5); C. 19; Ll. 40 - 42; Ltr. 6½ - 9.

This fish is very common in Bengal and Behar and provides one of the chief foods in these Provinces. They do not occur in the South Indian rivers. It adopts itself readily to still waters of a pond and trials of acclimitising it to South Indian waters are said to have been successful.

Barbles - maxillery thin and short, rostral some times present. Colour bluish or brown along the black becoming silvery along sides and beneath. A red mark on each scale could be seen sometimes. In some specimens, fins are black. It is said to be better than Catla for pond culture, though less quick in growth, for table. This fish is being introduced from Bengal into Madras water since 1944. Attains 3 feet in length. This is a favourite of Bangalis and is propogated with care in ponds in Bengal and Orissa. Lips fringed and is a mid column feeder having an anterior mouth. It is deep in body and narrow suddenly towards the tail. It breeds in rivers and bundh type of tanks just like Catla.

Labeo Contius.

Telugu: Pandimooti Chepa; Tamil: Karumula Kande.

B III; D. 15 to 16; (3 to 4/3- 4/12 to 13); P. 15; V. 10; A. 7; (2/5); C. 19; L1. 38/41; Ltr. 7/8.

This occurs commonly in Godavari and other South Indian rivers. Barbles 4 short. Colour: a general reddish or fleshy tinge. Darkest along the

back, with a red centre in each scale; found in the rivers at bases of Nilgiris. Grows to 2 ft. in length and suitable for pond culture.

Scaphiodon Bredvidorsails.

Neelamori in Telugu or Tamil.

B. III; D. 14 (3/11); V. 9; A. 7; Ll. 39 to 40; Ltr. 7 to 8/9.

Fins last undivided; dorsal ray ossius, very strong entire and longer than the head; colour silvery, darkest along the back; fins stained with grey. Snout rounded; mouth inferior and transeverse. No lower labeal fold. Barbels are absent. Found in South Indian Rivers and their tributories. Moves about in pairs and caught among the rocks; Good both for breeding naturally as well as artificially.

SILUROIDEA.

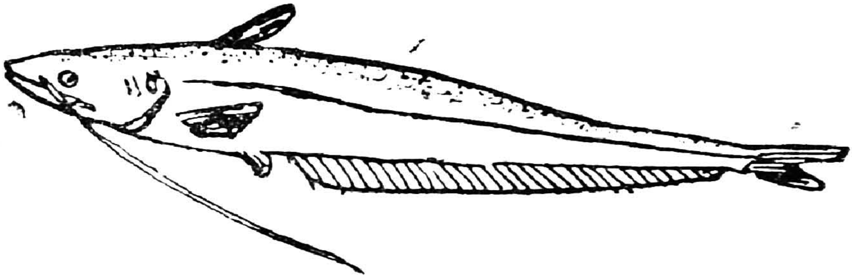
(*Cat Fishes*).

This variety of fishes have long barbles due to the presence of which they are called as cat fishes. Characteristics of these fishes are scaleless, carnivorous, likes muddy bottom; soft flesh; boneless and delicious than carps. These are common and numerous like the carps in the Indian waters, like mostly muddy waters. Usually these fishes have an additional dorsal fin called adipose fin. These have invariably numerous teeth.

WALLAGO ATTU.

(Fresh water shark)

Telugu: Valugu; Tamil: Valai.



B. XIX-XXI; D. 5; P. 1/13-15; V. 8-10; A. 86-93 (4/82-89½); C. 17.

This is the commonest and the best eating fish among the group. It attains 6 feet in length, and gives very good sport. In its movements very sluggish and lives mostly on animal and vegetable matter at the bottom of the water. It comes to the surface in the early mornings and late in the evenings in pursuit of food. This is essentially a tank fish and is very distructive to other fish. It devouvers another of its own size because of its carnivorous nature. It is called the fresh water shark and must be scrupulously eradicated from the tanks and ponds.

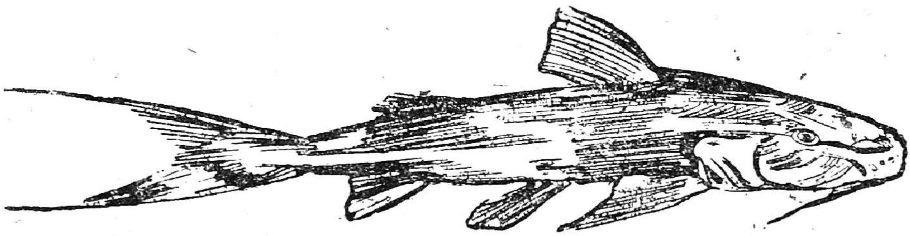
Gill opening wide, membrane of the gills is not confluent with isthmus. Body elongated and compressed, cleft of the mouth deep extending to below or behind the eyes. Head covered with soft skin. Lower jaw a little longer. Barbles 4; one

maxillery pair and one mandibular pair; teeth numerous in the jaws and on the omar. A short spineless dorsal situated above or slightly before the ventrals. Anal fin long and terminating near the caudal.

Colour:— Uniformly grey, fins sometimes covered with fine dots.

The liver oil of this fish is said to be 25 times more potent than the cod liver oil used for vitamin 'A' content. For detailed work see P. K. Seshan's article on "Vitamin Content on liver and deposits of fats of some Indian fish", appeared in the Indian Journal of Medical Research XVII. P. P. 711 to 720 of 1940.

Bagarius Yerrellii. (The Goonch).
Telugu: Rathi Jella;



B. XII; D. 1/6-0; P. 1/12; V. 6; A. 13-15 (3/10-12); C. 17.

It has similar habits like Wallago attu and grows upto 6 feet. Mounts to 300 lbs. in weight.

Barbels - maxillary with broad bases and rather longer than the head, the nasal pair short; skin somewhat scabrus over the summit of the head and slightly

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so on the body. Colour: body grey or yellowish with large irregular brown or black markings and cross bands. A black base to all the fins and generally also a dark band across each. It is ugly and voracious; sluggish. It has got adipose fin without ray.

MACRONES.

The genus Macrones also belongs to Cat fishes. They are termed as horn fish as they are armed with spines. They are predacious and should be eradicated from ponds and tanks. They are good for table.

Macrones Singhala.

Telugu: Mukku Jella.

B. III; D. 1/7; adipose fin without ray; P. 1/9; V. 6; A. 11 to 12 (3/8–9); C. 19 to 21.

Barbels maxillery extend to the middle just behind the dorsal fin. The nasal opposite to the middle of the opercle. The mandibular to the base of the pectoral while the internal are 1/3 shorter. Palatine teeth present; spine rather weak anteriorly rubose, indistinctly sarrated, posteriorly and as long as the head excluding the snout; pectoral fin is stronger than the dorsal and half as long as the head. This fish very closely resembles Macrones aor and chiefly distinguished by its much shorter maxillery barbels. Attains a considerable size. Black spot on the adipose fin, just at the junction of the adipose fin and the body.

Macrones Aor.

Telugu: Burra Jella.

D. 1/7; adipose fin with no rays; P. 1/9 to 10; V. 6; A. 12 to 13 (3 to 4/9).

Snout broad, depressed width of the nape being equal to 2/5 to 3/7 of the length of the head. Width of the head is 3/5 of its length. The longitudinal furrow on the head extends to the base of the exypital process. Barbles: the maxillery extend to or even below the base. Dorsal and caudal yellowish stained with dark externally. Attains 6 feet in length. It produces a sort of sound which is caused by pectoral fins and through the connection to the air blader, which is a peculiar habit in this fish. It scoops out small depressions in the muddy bottoms in river by its powerful caudal peduncle. The eggs are demersal. As soon as young ones are hatched out, they attach to the abdomen of the mother sucking the milky exudition oozing out of the skin.

Macrones Pungasious.

B. XI; D. 1/7; adipose fin without rays; P. 1/7; V. 6; A. 11 to 13 (3 to 4/3 to 9). C. 17;

Barbels: the nasal reach the hind edge of the orbit; the maxillery reaches the middle or the base of the ventral fin; the external mandibular reaches the base of the pectoral fin; the internal are 1/3 shorter.

Colour: head and back dark! greyish olive, becoming yellow on the abdomen; about 10 black round spots along the lateral line; fins dusky except the ventrals which are yellowish. This fish is closely allied to Macrones corsula but its head is much shorter in the adult; its upper surface is almost smooth and its snout is not so flat. Attains 18" in length: good for table.

Macrones Corsula.

B. X; D. 1/7; adipose fin without rays; (P. 1/9; V. 6; A. 11 to 13 (3 - 5/8.) C. 17.

There are two other varieties in this species which are very small. M. cadasius (Nara Jella in Telugu) and M. titatius (Sukku Jella in Telugu.)

Silundia gangetica.

(Pala Jella in Telugu, and Ponathi in Tamil).

B. XI to XII; D. 1/7; adipose fin without rays; P. 1/11 to 13; V. 6; A. 40 to 45 (4/36 to 44); C. 17.

Barbles: a pair of minute maxillery but no mandibular. Ventral fin arising under the posterior dorsal rays and nearly reaching the anal. Colour: Bluish along the back, becoming silvery on the sides. Fins stained with grey, attains 6 feet in length very voracious.

Pungasius.

Tamil: Nakelithi.

B. IX to X; D. 1/17; adipose fin without rays; P. 1/12; V. 6; A. 31 to 34 (4 to 5/27 to 29; C. 19.

Barbels: The maxillery reach the base of the pectoral fin. The mandibular are half as long as the

head. Colour: Silvery dark along the back and glossed with purple on the sides, cheeks and under surface of the head shot with gold. Attains 4 feet in length and a foul feeder.

Cailchrus Bimaculatus.
(Dukadummu. Like Valugu).

B. III; D. 4; P. 1/13; V. 8; A 60 to 75 (2 to 3/58 to 72); C. 17;

Barbles: The maxillery pair reach the middle of the pectoral or the commencement of the anal.

Colour: Silvery, shot with purple; black spot on the shoulder behind the gill opening and above the middle of the pectoral fin. Attains atleast 1½ feet in length.

PSEDEUTROPIUS.

These are excellant as food but avoided as they consume offal.

Psedeutropius takree.
(Chalava Jella in Telugu).

B. VI; D. 1/6 to 7; adipose fin without rays; P. 1/10 to 11; V. 6; A. 43 to 52 (3 to 4/40 to 50); C. 17.

Colour: Silvery with a gloss of green along the back. Caudal straight with grey at its edges. Atttains upwards of a foot and a half in length and is good eating.

RITA (Banki Eddu).

Available in large rivers in India except Southern most parts. B. VIII. Barbels 6; the maxillery do not quite reach the posterior end of the head; the mandibular pair extend a little further; the nasal are very short; one strong spine and 6 rays in the first dorsal fin. Colour: dull yellow; dark or even black fins, available in Kistna river.

A R I U S.

(Samudrapu Jella or Chinta Jella in Telugu).

Distributed in the seas and estuaries in the tropical regions. Ascends fresh waters for food. On the West Coast of India species of this genus are largely salted and a considerable amount of coarse isinglass is procured for export to China by drying their air bladders. The breeding of these fishes is peculiar. The eggs of aerius are large – more than an inch in diameter. Males take 15 to 20 eggs in their mouths. They hatch in the mouth of the fish. This is a case of parental care and the process of incubation is called buccal incubation.

B. VI., D. 1/7; adipose fin without rays; P. 1/10
V. 6; A. 17 to 18; (4 to 5/13); C. 19.

Colour: Greyish silvery becoming white on the sides and below. Fins stained grey with a white outer edge to the anal.. Adipose dorsal with a dark blotch. The male is said to be brilliantly coloured at the time of breeding.

SACHOBRANCHUS. (Scorpian fish).

Telugu: Thelu Jella or Ingilayi.

B. VII; D. 6 to 7; V. 60 to 79; C. 19.

Pectoral spine serrated internally, Short dorsal. It inflicts poisonous wounds, even occasioning tetanus. (After catching break off the spine as a safety measure). Colour: Leaden; some times with 2 longitudinal yellowish bands. The young are copper coloured. The eggs are of pea green colour. Considered exceedingly wholesome and invigorating hence recommended to convelesscents. Attains a foot or more in length. Possesses an accessory respiratory organ in the form of a highly vascular structure extending from the bronchial cavity to almost the tail edge.

Clarius Magur.

Telugu: Marpu.

These fish are amphebeous (live for some time after removal from water) because they possess accessary branchial respiratory organs. B. V; D. 62 to 76; P. 1/8 to 11; V. 6; A. 45 to 58; C. C. 15; to 17. Barbels 8; Colour: Green or brown superiorly; lighter beneath. The vertical fins (dorsal, anal and caudal) usually with reddish margins. Attains a foot and a half in length. It is highly nourishing as Sachobranchus. Pectoral with a spine; inflicts wounds, serrated finely but covered with skin. This has got long drawn dorsal. Bottom feeder; breeds from June to July.

Gliptosternum.

Tamil: Kalkava

These fish are specially adopted for strong hill streams. (Another Spp. is Discognatus: which is a scale fish in carp family). They have some adoptatious to be attached to stones and keep against torrential floods. B. VI; D. 1/6; adipose fin without rays; P. 1/10; V. 6. A. 10 to 11 (2 to 3/8 to 9). Barbels 8; Colour. Yellowish with dark bands, fins yellow with black bands. Not important as food fish.

Genus: OPHIOCEPHALUS.

Chief characteristics:— Scales on the head and 1 dorsal fin. These are predacious fish and not to be mixed with others. Of very good nutritous value, highly delicious, and easily digestable. O. marulius is the biggest member of the genous, and O. gachua (Mattagidasa in Telugu) is a good larvicidal for high and low altitudes for fresh water. Takes 2 years to breed. Eggs are large 1. 2 MM in diameter and float on the surface. They will vary from few hundred to thousands. Breeding season twice a year –. December – January and June to July. Breeds in dark night and takes 24 hours for hatching. It seems that the same pair do not breed twice.

The following is the account given by A. St. Macdonald about these fishes, published in the Journal, Bombay Natural History Society, Vol. 45.

"The group of Murrels (Ophiocephalus) are popularly known as snake-headed fishes. In virtue of their accessory respiratory organ, they can live in any kind of foul water. The body is sub-cylindrical, tapering from the flattened snake-like head to the rounded caudal fin. Large and irregularly shaped scales are present on the head. Lower jaw is longer; the maxilla reaching below the hind edge of the eye or sometimes even behind it. The teeth on the inner row of the lower jaw are conical while those of the palates are cordiform. The dorsal fin is continuous, arising above the pectoral which does not quite reach the anal. The head and body are covered with scales. There are about 18 to 20 rows of scales between the snout and the orgin of the dorsal fin: nine rows between the eye and the angle of the preopercle. The number of rows between the lateral line and the dorsal fin is subject to variation. The fish is dark greyish above becoming dirty. white beneath, cheeks and lower surface of the mouth streaked and spotted with grey; bands of grey or black are seen from the sides to the abdomen. It is able to servive out of water for a considerable time. Excellent table fish, and one of the favourites with the natives. It might be claimed that in any tank or stream where weeds prevail, this fish will be found even though the tank dries up they still survive aestivating through this period. They can be seen at the surface of the water basking in the sun in the middle of the day, when they can be shot, though this is not sporting.

Parental care:- The Murrel exhibits a keen parental affection towards the young, and can be

seen working along the edge with a cloud of black yougsters over it. It furiously attacks any fish which comes near, and can be taken by a bait with ease though it is a shame to do so.

Beware of stocking tanks with this fish, where are other varieties. They have no principles, and will even eat their young after they have attained a reasonable size.

Tackle;- Light tackel or stout gut or fine wire for preference, as the teeth soon fray the gut; fished for in the manner for Pike, though he can be taken by better means if the opportunity comes your way.

These fish abound in great numbers in the large tanks or lakes built as rain water reservoirs. There is generally a fringe of weeds running along the edge of the tank to about 8 to 10 feet. These fish can be seen on occasions, in the evening, feeding in shoals along the outside fringe of weeds. They move in one direction, and are located by a continual bob, of black snake-like heads on the surface. A light rod and cast, with a fair sized hook run through a mole cricket, and cast into the shoal gives excellent sport, and 5 to 6 fish can be taken in this way out of a shoal, by following them up. The other method also tried out is baiting in the clearing of the weeds on the edge of the tank, where Chilwa collect. A live bait is fixed lightly through the back and lowered to a depth of three feet below the surface. The Chilwa are collected and the Murrel is signalled by a thousand small fish jumping out all round the float, like a fire-work display. The next movement the float goes and you have your fish."

Ophiocephalus marulius.

Telugu: Poolachepa or Chavada;
Tamil: Aviri or Chouda.

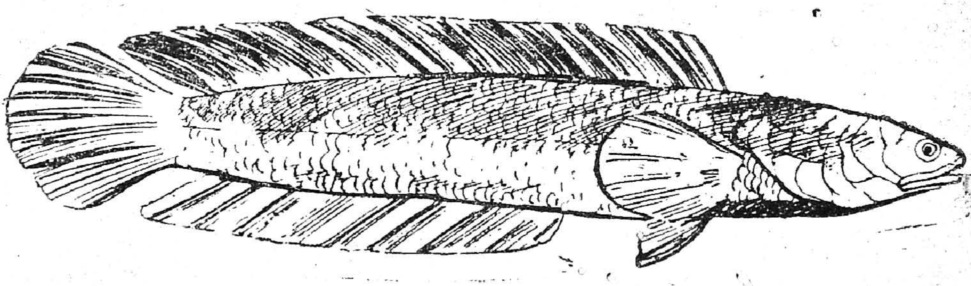
D. 45 - 55; A. 28 - 36; Ll. 60 - 70; Ltr. 4½ - 6½/13 - or 5½ - 8½/13 - 11.

Colour varies with age and the water. Black greyish green. The young have a brilliant orange band passing through eye to the middle of the tail. In the more mature there are 5 or 6 cloudy bands discending to below lateral. Abdomen orange on the posterior third of body. On the dorsal, anal and caudal fins there are pearly white spots.. There is generally a large black ocelus (black spot) at the upper part of the base of caudal fin which is grey. Ventral orange. Attains 4 feet in length.

Ophiocephalus striatus.

Telugu: Poolachepa or chavada; Tamil: Veral.

D. 37 - 45; A. 23 - 26; Ll. 50 - 57; Ltr. 4½ - 7/9 7 or 5½ - 8/10 - 9.



Colour dark greyish or blackish superiorly. Dirty white or yellowish white beneath. Cheeks and lower surface of the mouth streek and spotted grey. Bands of grey and black on abdominal sides. Some spots and dots on the posterior end of dorsal. Dorsal and anal greyish with some whitish lines or spots along base of the later. In the end there is occasionally a large black ocilus at the base of the dorsal and the body may be clear of any marks. Attains more than 3 feet in length. Takes bait especially frog readily.

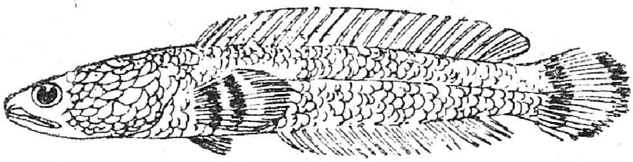
Ophiocephalus punctatus.

Telugu: Korra Meenu; Tamil. Korava;
Bengali: Lata or Taki.

D. 29-32; P. 17; A. 21-23; C. 12; Ll. 37-40;
Ltr. 4-5/9 or 9/6; C. 12.

Colour varies with the water. Black greenish becoming yellow on the sides and abdomen with a dark stripe along side of the head. Several bands from back pass downwards to middle of the body. Fins spotted. Vertical fins are with a narrow light edge. Dark nasal band. Ventral white or grey. Some have scattered black spots over the body and head.

Ophiocephalus gachua.



Telugu: Mattagidasa; Tamil: Parakorava;
Bengali: Cheng.

D. 32-37; P. 15; A. 21-23; L1. 40-45;
Ltr. 3-4/7-6; C. 12.

Colour varies materially according to the water in which it inhabitates. Usually greenish, lighter beneath, Dorsal, Caudal and anal are slate coloured with orange margins. Pectoral with a black, base having a slight reddish or orange edge. Caudal barred. Occassionally the body is spotted with white or orange. Attains more than a foot in length.

Muraenidae.

EELS.

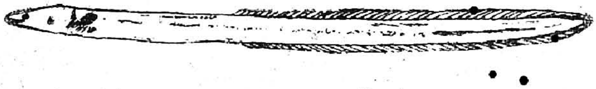
There are two varieties among eels. Spiny and spineless. Spiny eels are: Mastacembelus and Rynchobdella.

Telugu: Bommidai; Tamil: Mudi-Bommi-Dai.

Spineless eels are Anguilla bengalensis and Anuguilla bicolor.

Telugu: Malugu pamu or Dondupamu;
Tamil: Velangu; Bengali: Bammachh;
Hindi: Kalan.

Anguilla Belongalensis.



This is considered to be very nutritious and rejuvinating, next to tiger flesh which is very effective for vitality. This migrates into sea from rivers and is catodromous. This is a snake like fish; head is broader than the body with a prominent lower jaw. The length of the cleft of mouth is about 1/3 of the head and it extends behind the posterior margin of the orbit. This is a very irritable fish and swells its head whenever it is angry. Colour: Brownish on the back becoming yellowish on the sides and beneath. The upper surface of the body is sometimes covered with dark spots and blotches. The anal fin has a dark marginal band and a light outer edge.

Mastacembelus armatus.

Telugu: Bahm; Tamil: Mudi-Bommidai; Bummi and Gonti: in Oriah and Bengali.

This is called spiny eel distributed through the waters in India. Attains more than two feet in length and is considered nice eating. Darkbrown above becoming lighter beneath. Pectoral fins are spoted and the dorsal and anal fins have bands or spots.

Ophichthys boro.

Telugu: Mattibukkada Paum; Tamil: Kuthu Paum.

Enters fresh waters from sea. It digs holes in the bunds by its strong snout; just like crab. Brancheo stegals XXIX to XXXI; D. 320 to 400; P. 13; A. 250 to 270. The natives of Bengal imagine that the fish proceeds from the ear of

tortoise. In some parts of Madras those captured in salt water creeks are eaten by the people as a remedy for weakness or pains in the loins. This is an agricultural pest burrrowing through the bunds of the paddy flats. It attains at least 2 feet in length. Colour- Greenish olive above with minute black spots becoming greenish white below. Dorsal fin with a dark edge.

MUGILIDAE.

Mullets or Mugils.

Telugu: Bonthalu or Moyyalu; Tamil: Parandai.

General characteristics of mullets are 2 dorsal fins and adipose eye lids. They cause small shoals disturbing the surface with concentric rings frequently by their movement. Frequently jump to the surface. Have small scales. There are three colour in mullets. White mullets: Chanos chanos; Grey mullets: Mugil cephalus or oeur: Red mullets: Mugil dussummeri. Grey mullets or ordinary mullets have several spp. which are all marine except single fish Mugil corsula (fresh water fish). This has an aerial vision - breeds in fresh water. Available in bengal and introduced to Madras in 1945. Among the marine species Mugil sephalus or M. oeurand; Mugil dussemmerri are good for acclimatisation and rearing in fresh waters.

Mugil cephalus or Oeur.

This is the best of mullets that could be acclimated to fresh waters and it grows quickly and to a big size, from 10 to 12 inches. The distinguishing characteristic is a blue band round the pectoral fin,

Mugil dussumeri.

This comes next to Mugil cephalus.

Mugil corsula.

This is a freshwater fish and it can breed also in confined waters. The distinguishing feature is that it swims at the surface of the water with the eyes protruding above the surface. This is known as aerial vision. The eyes are protected with a tissue called adipose eyelids. This is only available in Bengal. Attains 2½ feet in length; Good for stocking tanks and table.

The favourite food for mullet is lab lab, a plant complex thriving at the bottom of the ponds and estuaries. Next to this is hair weed or spyrogyra in fresh waters. Another kind of green food for mullets is Netella - which is of brackish water. This is bottom feeder and feeds on vegetation.

Chanos chanos.

White mullet or milk fish; Telugu: Pala Bontha; Tamil: Thullu Kandai.

Colour: Summit of the head and back is of a brilliant glossy blue, fading into silvery on the abdomen. Snout light brown. Dorsal and caudal rays - greyish; pectoral and ventral: white. Attains 3 feet in length and 20 to 30 Lbs. in weight. Thrives better in fresh waters and quick growing second to Catla in growth. For collection, it cannot

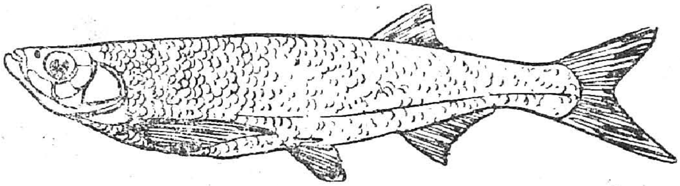
be mistaken. High nutritional value and beautiful to look at. Spawning: April to June. Bottom feeder.

The following is an interesting account given by a fisheries expert: "Chanos chanos (salmonius) which is popularly known as milk fish on account probably of the white colour of the flesh is an estuarine fish which is very extensively cultured in Philippine islands. This industry has been estimated to be worth about Rs 13 crores around Manila bay alone. This fish possesses very many characteristics which make it suitable for cultural treatment. The adult and fry are vegetable feeders, certain filamentous algae and diatoms being the chief. They breed very prolifically and they are quite hardy as they can withstand great variations in temperature and salinity. They thrive in fresh water also. I had occasion to examine a sample of the natural food of the Chanos fry called "Lab-lab", in the Philippines, the filamentous algae and diatoms composing it are closely allied to those noticed in abundance in the swamps and creeks of Sunderbans. The fairly impervious soil is also another favourable factor. Consequently there is a vast scope for introduction of Chanos farming on a large scale in the Sunderbans. Though Chanos fish had been recorded to be present in the estuaries here yet it does not seem to be common as I had not seen it among any of the catches during my survey. However, a few thousands of fry can be obtained and transplanted from South India where the Fisheries Department has been experimenting in some of their fish farms." For details on Chonos culture read Bangos culture in the Philippine Islands by Albert W. Herre in the Philippine Journal of Science Vol. 38 No. 4, 1929.

CHILWA.

Chela argenta.

Tamil: Chaya-vellachee or Vellachee-candai.



D 9 - 10 ($\frac{2}{3}/\frac{7}{8}$); P. 15; V.8; A. 17-19 (3/14 - 16); C.19; Ll. 43 -45.

This is a larvicidal and game fish. It has long and compressed body. This is a very delicate fish with the abdominal surface narrowing to a fine edge. It has an up-turned mouth and keeps itself at the surface of the water. They form good food for bigger fish like Mahseer and Murrels and in its turn, it searches the shallowest waters for insect food and keeps musquito larvae under control. It is of silvery colour with a lateral band which fades after death. Can be reared in tanks and ponds well.

Gobidae.—

Glossogobius giuris.

Telugu: Isakadontu: Tamil: Oolloway.

D. 6 $\frac{1}{8}$-9; P. 20; V. 1/5; A. $\frac{1}{8}$-9 C. 17; Ll. 33-34.

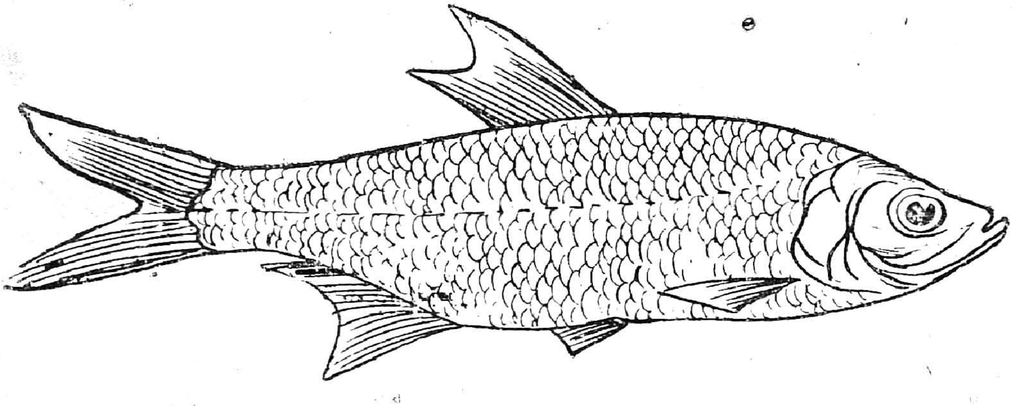
Bottom feeders, sandy coloured bodies dotted black irregularly. Hiding amidst stone and sandy pebbles and stones. Can be easily got on the hook

and very good for the table. Ventral fins are united to form a cup like structure. They are carnivorous and should be eradicated from ponds and tanks where cultural operations are in progress with other spp. This is a common fish in any river, tank or pond. Attains a foot and a half in length. There are two dorsal fins, the first with a few spiny rays and the rest are all soft rays. The caudal fin is either pointed or rounded.

Megalops cyprinodes.—

Oxed-eyed herring.

Vernacular. Kannangi or Moran candai in Tamil
Telugu: Kannangi.



Characteristics:— Large eyes; last ray of the dorsal fin elongated, big scales. This is the sea fish acclimatised in fresh waters. A game fish and highly predaceous. Though it is called a big eyed carp, it is not carp.

B. XXIX to XXXVI; D. 19 to 21; A. 24 to 27;
C. 19; Ll. 37 to 42; Ltr. 5 to 6/6.

Colour: Back bluish green in the adult; lighter in the immature; abdomen silvery: margins of the scales brilliant silvery. Centre of the jaws black. Dorsal and caudal greyish, minutely dotted with black margins; Pupils oval pointing downwards. Eyes with adipose eye lids. Caudal is deeply lobed; Commonly found in tanks and occassionly in rivers.

Clupeidae.—

Hilsa. ilsha.

Telugu: Polasa; Tamil: Ullathi.

Characteristics:— Cutting abdomen by the modification of scales into scoop. Upper jaw not projecting over lower; mouth oblique (wide or narrow) and more or less subterminal; last ray of dorsal fin not prolonged.

Another variety in this is Hilsa toli - smaller variety. Hilsa ascends fresh waters from the sea when the mud in the water begins to clear. Hilsa is much esteemed as a very tasty fish. Hilsa is a very fast swimmer. While feeding in fresh water, its flavour and taste will be affected. For this reason, Hilsa caught near the sea is much prized. Colour is bright silvery shot with purple. Grows to about 18" in length and it is not ordinarily found below a depth of 12 feet. It breeds in mid-waters of the rivers and its eggs being heavier drop to bottom. The sexes are readily recognisable. The females are broader and longer than the males. Males mature earlier and commence spawning even when they are 9 inches long while the females attain maturity when they are about 13" in length.

Seven Stages of Fish.

The following is the maturity scale adopted by the International Council for the exploitation of the sea and this also holds good for fresh waters.

1. Immature: Bonnets very small, often hardly recognisable; eggs invisible to the naked eye; transparent under microscope.
2. Bonnets of length slightly more than half the length of the body cavity. Some eggs opaque and just visible to the naked eye.
3. Bonnets about 1/2 filling the body cavity, eggs opaque.
4. Bonnets above 2/3 filling the body cavity.
5. Mature organs filling the body cavity, but not discharging. Some large transparent eggs.
6. Spawning organs discharging or about to do so. Large transparent eggs. For artificial hatching this is the best - but difficult stage).
7. Spent (discharged) organs blood shot (blood spreading all over), large residual eggs present. (If the eggs are not discharged they will be absorbed. The egg binding occurs.)

Types of eggs.

There are 3 types of eggs in fish.—

1. Pelagic: floating. Ex.- Carps; Murrels.
2. Demersal: Sinking. Ex. Hilsa.
3. Adhesive: Cluster, attached to objects. Ex. Extroplus.

Eggs appear as white forthy mass.

Utility of Fish as larvicides.

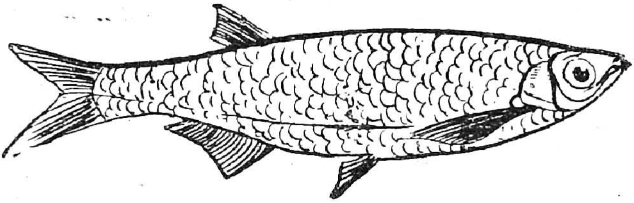
Fish play an Important part in keeping, down fly Pests such as musquittos etc.—

The young of most of the fresh water indigenous fishes of India attack and destroy mosquito larvae: but as some grow to a large size they are only useful during the fry stage. In selecting the best of the larvicides it is only necessary to include those that rely chiefly on the larvae for their food supply it being their natural diet. The following selection will be found a very useful one, the geographical distribution of each genus being widespread:-

Genus-Chela.

Description of genus (Dr. Day).— Body elongate and compressed: abdominal edge cutting Mouth directed somewhat upwards with the lower jaw prominent. Barbles absent. Pharyngeal teeth hooked and slender, in two or three rows. Dorsal fin short, without any osseous ray, situated principally or entirely opposite the anal, which latter has an elongated base. Pectorals long. Caudal forked. Scales of moderate or small size. Lateral line concave.

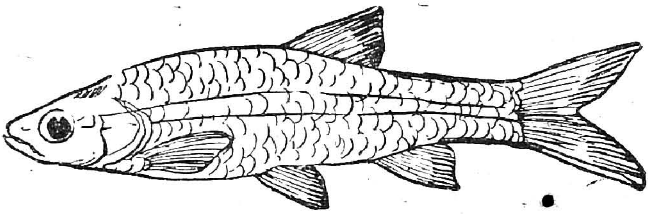
These fish are surface feeders and their chief diet consists of flies and larvae. (All species are good, the smaller ones being the best).



Chela bacaila (Hamilton).

Tamil: Vellichee Kandoi; Telugu: Bedisa.

Genus – Rasbora.

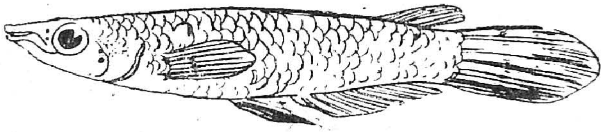


Rasbora daniconius.

Tamil: Paravu or Ohiri Kandai; Telugu: Pakki; Kanarese: Neddeam Jubbu; Malayalam: Kokantchee.

Abdomen rounded. Clerft of mouth oblique, lower jaw slightly prominent, having one central and on either side a lateral prominence, fitting into corresponding emarginations in the upper jaw. Barbels two rostral or none. Eyes with free lids. Pharyngeal teeth. Dorsal fin without any osseous ray and few branched ones, inserted posterior to the origin of the ventral, but not extending to the above the anal, which latter is short. Scales large or of moderate size. Lateral line concave continued to the middle or lower half of the caudal fin. Gill rakers short.

Haplochilus Genus.



Punchax lineatus.

Tamil: Mundakanni, Paravai; Telugu: Sukkuchepa and Keethakai; Kanarese: Kud-di-an.

Body somewhat elongated and compressed. Upper surface of head and nape broad and depressed. Teeth villiform in the jaws, present or absent in the palate. Dorsal fin short, commencing behind the origin of anal, which latter has an elongated base. Scales cycloid and of medium size Lateral line absent. A white occipital spot invariably present. (Note:- This occipital spot is under the control and if the small fish is frightened or for other reasons, it can render it invisible).

Haplochilus thrives best in clear shallow fresh and brackish waters of low altitudes maintaining a very gentle flow and supporting thin leafed vegetation. It starts breeding when about an inch and a half long (4 to 5 months old). It is a prolific and perennial breeder, eggs, round and highly yolkladen with several oil globules. The eggs have anchoring tufts of adhesive filaments and are laid singly attached to the submerged vegetation. They hatch in less than a fortnight. The larvae is about a centimeter long and has a pigmented shape and belly. It feeds on planktonic micro organisms. The larvae assumes

the character of the adults in about three weeks After that the fish continue to subsist mainly on the larvae of mosquitos, and tiny crustacae, while worms and minute molluses are occassionally taken in. Vegetable matter is rarely consumed and even that accidentally. The high efficiency of this fish has been definitely established.

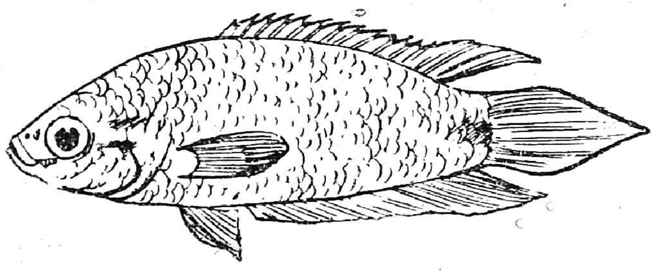
Genus–Therapon.

Brachiostegals six. Eyes of moderate size. Opercle with spines. Pre-opercle and some times preorbital serrated. Teeth villiform in both jaws, the outer row being sometimes the larger deciduous ones on the vomer and palatines. Dorsal fin single but more or less notched, having from eleven to thirteen spines: anal with three. Scales of moderate or small size. Air vessel divided by a construction.

This is a most useful species and can be found in all backwaters and live and thrive in brackish and fresh waters.

GENUS — POLYCANTHUS.

Macropodus cupanus.



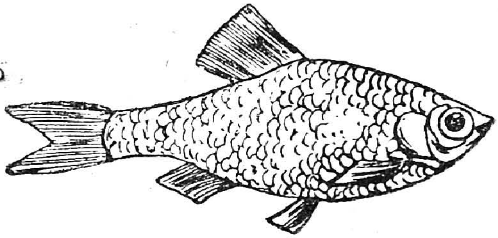
Tamil: Punnah, Paravai; Telugu: Heb-bu-ti; Malayalam: Caringanah, Wunnuttee; Kanarese: Ta-but-ti.

This fish is distributed in the fresh waters and estuaries along the coast of India and Ceylon. It is a most effective destroyer of larvae in both fresh and brackish waters and can be transported to long distances easily being an air breather.

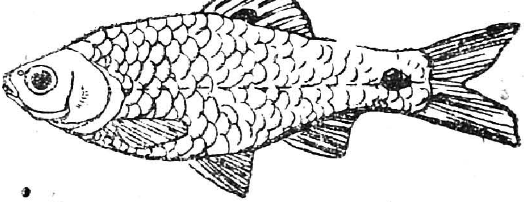
Scales large; body elongated and compressed spineless opercles; single dorsal fin; ventral fin has one spine and five rays usually elongated.

Genus – Barbus.

Barbus ticto.



Barbus (puntius) sophore.

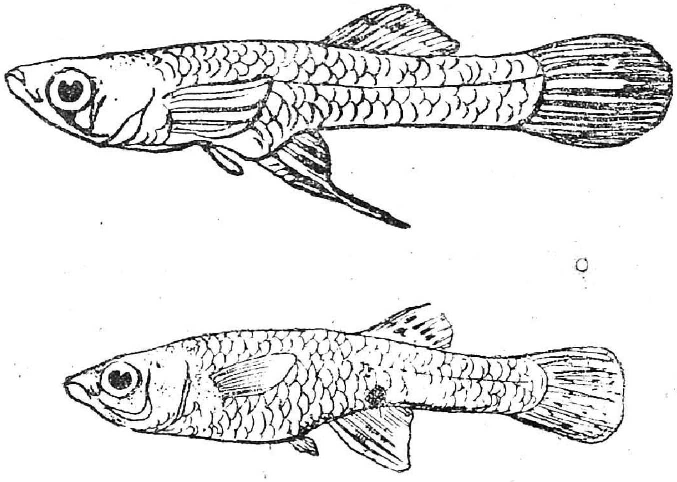


Barbus (puntius) phutunio.

Telugu: Parigi; Tamil: Kendai;
Kanarese: Kattchi karawa.

These speceies are most common and are very valuable larvoe destroyers. Mouth will be both anterior and inferior and arched. The lips have leathery lobes; pharyngeal teeth in the mouth; dorsal fin commences approximately opposite to the ventral fin.

Gambusia affains holbrookil (Girard).



This is the most famous and is very much used in combating malaria. It is called "Top Minnow" and was imported into India from Italy and Siam about 20 years back. This is very voracious and a hardy one. Viviparous and is a very exotic breed.

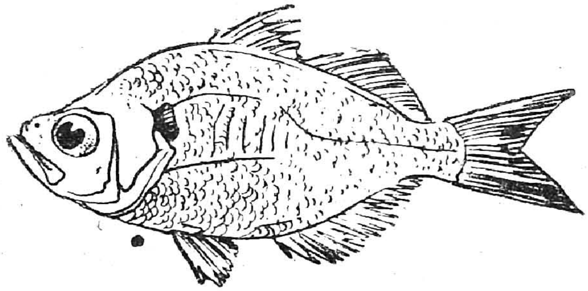
GUINEA WORM CONTROL

Cyclops transmit the larvae of guinea work to the human host.

Cyclops. Length – up to 2/5 inch.

The gloss fishes Ambasis ranga and A. nama have been found to be very useful in the destruction of cyclops. They are very small and they thrive extensively in standing and running waters of India and Burma. They have spines in their fins. Mouths and gill takers are well adopted for filtering cyclops and such other micro-orgonisms. The adults feed at all depths of water and subsist on cyclops and other microcustacae. Thus they are ideal cyclopsidol fish which can be effectively employed in anti-helmin campaign.

AMBASIS RANGA. (glass fish).



Little insects of the water.—

Though little fish often form the food for larger fish, a great many of them depend on the little aquatic insects which can be found abundantly in the water. A brief study of these little insects will be interesting to a pisciculturist since without them, the larger fish cannot exist.

(From Cornell rural school leafleft - Vol. 32, No. 2)

EUGLENA.

Euglena viridis Ehr. Phylum Protozoa. Class. Mastigophora (Flagellata); Order Euglenoidida. Family Euglenidae.

Common in barnyard or pasture pools where there is manure or green scum. Culture, by boiling 7 grains of rice in a pint of distilled water; allow to stand until scum forms, then inoculate.

Characteristics.- Microscopic animals less than 1/250 inch long; somewhat pindle-shaped, with a swimming filament at the end. May lolour ponds green when in great abundance. Sigle-celled organism.

Control and use:— Basic food for many higher organisms and serve excellently as organisms which break down organic matter, thus making way for others. Cultures should be stated 8 weeks before needed.

AMOEBA. (Amoeba sp.) Phylum Protozoa.

Class Ciliata. Order Holotrichida.
Family Paramecidae.

Commonest on aquatic plants such as Caboma, Anacharis, dead water-lily pads which are rotting Culture *in 2 centemeters water with four grains of wheat five of rice: or six. One inch lengths of timothy.*

Characteristics:— One celled animals under one fiftieth of an inch in diameter without definite form which is maintained. May divide by breaking, or may move by unique foot like projections (Pseudopodia).

Control and use: Help in reducing organic compounds in moist places and serve as food for others. Some are associated with diseases of larger animals ? dysentery being caused by amoebae.

WATER FLEAS.

Live year round in clear or dirty water where algael and bactirial food is available. Do not thrive in copper or zinc containers. Length about 1/12 inch, with distinct tail spine, and swimming structures at head. Almost transparent.

Ideal aquarim food for hydra, young tadpoles, normally reaching maximum population in 21 days at temperature of 70 to 80 degree F.

PARAMECIUM.

Phylum protozoa, class ciliata.—

Common in fresh water, brackish water or salt water depending upon the species and the food available. Culture in hay infusion, in water and egg yolk, and on water culture of oat straw.

Charateristics:— May divide every 8 hours in suitable culture. One might be responsible for

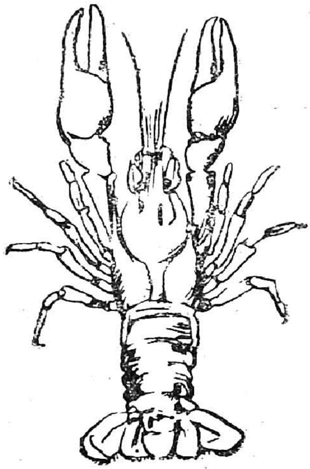
268,000 monthly. Live on smaller organisms and favoured as food by DIDINIUM, a protozoan. Swim in a screw-like spiral.

Control and use:— Basic food for many organisms important to still larger, more important species. Ability to reproduce rapidly provides effective means of doing its work quickly.

Fairy Shrimp.

In fresh-water pools and ponds from fall to spring, summering in egg stage. Length to 1 inch; transparent to pink-green. This serves as food for many small aquatic animals and thus control still smaller organisms.

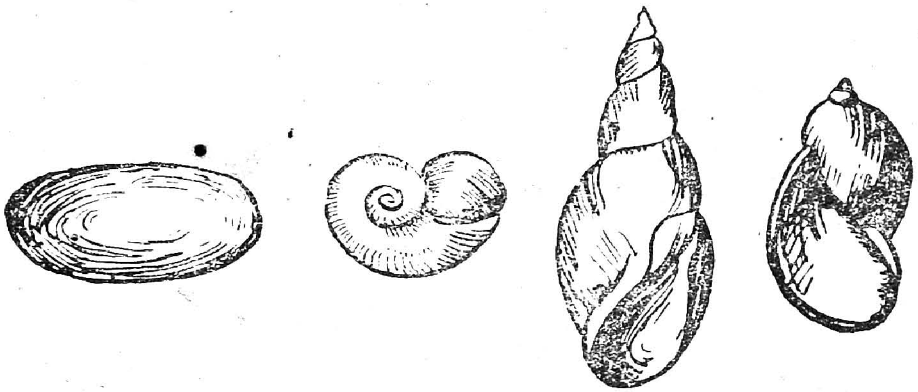
CRAYFISH.



Length 1 to 5 inches, with 2 large claws in front, 4 pairs of walking legs; long and short "feelers" and jointed tail, which permits rapid backward swimming. Male has first appendage of abdomen hooked; female, unhooked.

Found in streams and ponds usually where there is mud, but frequently habitate in swift water in burrows. Live 6 or 7 years lay 200 or more eggs. Food.- animal matter caught by strong pincers. Sensitive to light and most active at night. These are essentially scavengers, but serve as valuable food for useful fish; may distroy fish eggs in considerable numbers. Convert much useless plant and animal material into food for larger forms and man.

POND SNAILS.



Found in fresh water; sometimes in salt water and also on land. There are about 19,000 kinds of fresh-water and land sails known. The land forms have two pairs of tentacles and the water forms have 1 pair. Mate usually by joining right side of bodies. Male part of one mating with the female part of the other. Lay numerous eggs which hatch within 2 to

3 weeks. Some are carnivorous, but most live on plant material. These are chiefly scavengers of the water. Also serve as basic food for many water animals.

FRESH WATER CLAM.

Two nearly equal shells, each about 1/2 inch long and nearly as broad. Usually a shining yellow-brown colouring with fine rounded ridges on the surface, curved around a center at the hinge which joins the shell. Found in sand, on plants in streams or somtimes burrowing in mud bottom Minute eggs, comparatively few in number, laid in the gills of the female where they develop. Fine organic substances strained from the water which is taken in over the gills, is their food. Serve as scavengers and as food for fish and other aquatic animals.

WATER SOW BUG.

Length 3/5 inch; Breadth 1/5 inch. First pair of legs modified for holding; the others for walking, the last 3 pairs the longest. A single, shield-like plate on abdomen.

They are common among fresh water vegetation and in the oozes at the bottom of ponds and pragnant pools. Their food is dead or living plants or animals. In some cases, the mother may eat her own young, or the young eat their brothers and sisters. Move only by walking, but may burrow to some extent covering the gill openings to the rear with abdominal plate to avoid suffocation. They do not favour strong light or dryness.

These are scavengers of the water and important in turning waste materials such as plants into animal food for larger forms of life.

FRESH WATER SHRIMP.

Upto 5/8 inch long, with bodies laterally compressed and higharched backs, rather conspicuous antennae and a brood pouch carried beneath the larger female. This is the commonest of the small fresh-water, shrimp-like insects in lakes and streams. Its food is living or dead plants or animals, large or small, unable to offer any strong resistance; may eat their own kind. Swim backwards frequently on their backs, by means of swimming legs. Mated pairs may swim together for a long time. Protection by escape, numbers, and inconspicuous appearance; may appear almost ghost like.

These are among the best organisms of value in converting plants and small animals into suitable food for valuable fishes. Important as fish food in hatcheries and in nature. Scavengers also. Too small for human food.

DRAGON FLY.

Adults 4 winges; wings spread at rest; large eyes; relatively slender abdomen, meduim sized legs; most active fliers, favouring sunlight. Nymphs, aquatic, with conspicuously hinged lower jaws; some burrow (Gomphus) some sprawl (Libellula); some climb on water plants (Aeschninae). Males have single appendage at end of abdomen; may hold

female by neck. Females drop eggs in water, insert them in mud or in plant tissue. Usually long incubation, though sometimes about 2 weeks. One brood a year beginning in June. Incomplete metamorphosis. Adults and nymphs feed solely on animal matter. Harmless at all times. Often highly inquisitive, investigating a variety of possible sources of food supply. May roost in considerable numbers at night. These are lovers of bright sunlight and warm weather, commonly parasitized at different stages, particularly the eggs, by wasps. They are useful as desetroyers of insects such as mosquitoes and gnats but may also prey on useful insects. This is the most beautiful and graceful of all insects.

FRESH WATER MITE.

Length ⅛ inch or more, commonly less. They are generally spherical or egg-shaped with 8 legs attached to the fore part of the body. Legs usually 5 jointed and in some species, with swimming hairs. They are aften red and with numerous minute suckers on under side. Found in fresh water on various small animals; some leave the water to live on air insects and some in sea. Eggs usually laid on stones, sticks and other objects; hatch into young having 6 legs and developing through a complicated series of changes depending on the species. Some spend a part of their life on one host and others on another. Their food varies with the groups, eg., mollusces, mosquitoes; water striders etc. These are the parasites of the fish.

MAY FLY.

Adults have thin, delicate wings held over back in rest. Usually with 3 but sometimes 2 long delicate "tails" and with font pair of legs held consipicuously forward. Adults can be seen in great flocks along fresh water rivers, lakes and ponds. Nymphs under water. Adults live but a day or two, mating in flight. Famales drop eggs or place them under water: 500 to 1000 per female batch and develop through immature stages in 6 weeks. They molt in adult stage unlike other insects. Normally adults take nothing as food since mouth parts are not developed. Immature forms feed almost entirely on submerged aquatic plants, oozes, and slimes of the bottoms of water

These form a valuable basic food for many valuable fish.

DAMSEL FLY.

Adults slender bodies, with notted wings which fold along back when at rest. Heads and eyes, large. Males frequently more brilliantly coloured. Incomplete change. Adults relatively slow flying. Nymphs in ponds or streams but probably most common in quiet water. Males hold necks of female with claspers. Male sex organs near front of body. Females may lay 200 to 300 ovate eggs, 1/25 inch long, by inserting in water plants hatch in 3 weeks to several months and in 10 to 14 stages. Food of nymphs probably any aquatic animal life which may be captured and of adults, insects which may be captured in flight.

This also forms food for fish. Interesting and sometimes beautiful to watch along waterways.

STONE FLY.

Four winged insects with chewing mouth parts: mouth sometimes does not function in adult. Incomplete change with the nymphs aquatic, with gills most commonly just behind base of legs in pads and with two "tails" Adults fly reasonably well. Adults on land or flying. Nymphs in well-aerated water, usually where it flows.

Male out of water. Females drop eggs in masses in water: 200 to 800 eggs, hatch into nymphs which cling to stones under water and mature in 1 or more probably 2 or 3 years, then leave water to transform into adults. Food of nymphs, small forms of animal life captured while prowing over or under submerged stones in a stream. Adults may eat nothing; die soon after eggs have been deposited. Protection against current by stream-line form of nymphs; from animal enemies, by position in current and by ability to hide. These are useful food for fishes and are scavengers of water. Adults make excellent trout bait in season.

BLACK FLY.

Adults small, short stout-bodied, humped backs and short legs. Males with continuous eyes and females with seperated eyes widely. Larvae, are like worm with a sucker disc at tail end and a fringe at head. The adults are found in air in great numbers in season and larvae in water. They

mate in the air in early summer on rocks washed by current. Lay white or yellowish eggs which become black and develop into larvae which stand erect in rapidly flowing water, often making black blotches on bottom. Food of adult female Adirondack black fly is blood. For males the food is plant juices. Protection by numbers, by inaccessibility of region where larval stage is spent and by escape. They require well-aerated water. They see with upper halves of the eyes during night and by day with the lower halves. Got a well-developed sense of locating food.

Some form the worst insect pests of the woods in early summer and of cattle and other Domestic animals. All larvae useful as food to fish able to get them.

CRANE FLY.

Adults long legged and having 2 wings with a V shaped suture between them. Larvae, usually grayish white, with or without appendages at one end, an inch or more long and about 1/8 as thick Adults could be found in air or among damp vegetation. Larvae can be found on land, under wet soil or in water. Pupae will be commonly in gravel. One species lays about 1000 eggs which hatch in about a week into black worms or leatherbacks and develop eventually into pupae which live about a week before transforming to adults. Larvae vary greatly in food and habitate. Some adults have flower nectar as food. Larvae take sometimes animal matter; others act as scavengers and still others are plant eaters. Protection of adults escape, and of larvae hiding. Adults are

attracted to light. They form clouds of dancing individuals at definite times of the day. Larvae of some nocturnal.

*Make good food for fish and larvae make excellent bait. Some larvae destroy meadow plants and injure pastures seriously. Controlled by poison mash of *1,lb. paris green to 25 lbs. of bran with water.*

MIDGE,

Adults like small mosquitoes but more delicate abdomen, legs and antennae. Antennae of males, feather-like; of famales, only sparsely so. Larvae mostly aquatic: some red, known as blood worms, may remain hidden in a case of silk and oozes.

Adults are commonly flying often in dancing flocks of great numbers. Larvae mostly in water but some on land. Usually mate in air; a female may rop a brown mass of about 700 eggs into water. These hatch in 3 or 4 days into larvae which require from a month to 2 months or more to reach pupal stage, which swim like wrigglers near surface for a few days before transforming to adults. Food of adults of some species such as "punkies", blood, but larvae of most species feed on minute plants or animals of the environment. Some few larvae infest living plant material. Some eat the case which they make of pond ooze. Their activities are associate with light. Usually late in the day, they all may become active at once, causing a hum of buzzing wings. *Some woodland pests in season but most immature stages are valuable form of fish food forming the major Diet af many species which are valuable to man.*

WATER SCAVENGER BEETLE.

Usually, black, elliptic, more or less flat beneath and convex above; when in water, show undersurface silvery with a film of air. Larvae stouter than those of *Dytiscidae*, the fore parts being more slender and the jaws less conspicuous. Most species are found in fresh water, though a few live in moist soil or dung. After mating females lay about 130 yellow eggs enclosed in water proof cocoon-like structure attached to plants near surface or floating. Larvae crawl about under water going through at least 2 moults in a month and in late summer, for about 12 days, pass pupal stage in soil. Food of adults, largely decaying vegetation, but some feed on other small animals which may be captured alive.; larvae feed on small animals, sucking through hollow jaws. Adults fly from pond, to pond often being attracted by lights and falling helplessly to ground.

Food of some fish, scavengers of waste materials. Larvae eat any animals available in aquaria. Pests in fish hatcheries.

DIVING BEETLE.

Adults have hard fore wings. Usually black and brown and when under water show a buble at tail. end. Hind legs, modified for swimming. Females of some species have fore wings furrowed. Males of some, with disc on forelegs. Larvae, slender, with large jaws, active voracious and aquatic. Found commonly in ponds and streams

but particularly so in standing water. After mating around March or April, females lay 20 to 50 eggs, singly in slits in plants under water. These hatch in about 3 weeks into larve which develop in 4 or 5 weeks, changing into pupae which remain burried in earth from 10 to 20 days in summer or longer in winter. Adults and larvae have animal matter as food, captured in jaws and sucked into the mouth. Young larvae feed by biting and sucking, even attacking and killing their own kind. In captivity, may be fed on raw beef or on a mixture of cereal, powdered shrimp, and ant eggs ground together. May destroy fish and fish eggs. Adults fly from pond to pond attracted by light. *These are enemies of fish and other forms of water life but may themselves serve as fish food. Probably useful checks on Multiplication of such life as mosquitoes and their larvae.*

WHIRLIGIG BEETLE,
(Lucky bug, Write-my-name, apple seed, FAMILY GYRINIDAE.)

Relatively flat, oval blue-black or black and brown beetles with forward reaching fore legs and hind legs adopted for swimming and attached to centres of bodies permitting sudden changes of direction. Larvae, slender, with rather conspicuous abdominal appendages. Swim rapidly in spirals and circles on surface of water which is quiet or rapidly flowing. May fly from pond to pond. After mating females lay 1 to many white cylindrical eggs on submerged plants. These hatch into fierce-looking, slender flatened, light coloured larvae which finally leave water, spin gray, paper like

cocoons in which a month is spent before transforming. Food of young and of adults probably solely animal matter, usually captured at water surface alive. Apparently have four eyes, two looking upward and two down but experiments show that the lower pair do not function and are but a part of the eye which shows above. *Not known to do any particular harm and might well figure in mosquito control.*

DISEASES OF FISH AND THEIR TREATMENT.

In the nature, all life great and small must obey the laws. The struggle for existence and the survival of the fittest is worse in the water than on land. The laws operate stricter in the waters, for we note in the fish world, a wonderful absence of sick, week or even thin individuals in the shoals. As in the case of the beasts of prey, the ravaneous and predacious fish, promptly kill and devour the weaklings and the sick, leaving only the healthy as the fittest, survivers in the grim struggle for existence. The myth of kindness being human, there are no hospitals no pinjrapoles in the economy of brute creation. It is only where the pisciculturist or the aquarium keeper, takes over control that casuality registers, are maintained; Post mortem enquiries held and medical treatment given.

Only those who keep fish as pets, whether as a hobby in their homes and gardens or professionally in public institutions like aquarium, fish farms or hatcheries, know how amazingly long is the list of ills, the fish flesh is subjected to. The detection of

sick fish is easy. While the healthy ones are swimming about, or atleast waving their fins, this one is sluggish and droops its fins. Many are the causes for this. Generally such a condition is due to indigestion and constipation. The results are over feeding or the use of highly concentrated food. The sick fish should be removed to a bath containing one part common salt and one part epsom salt dissolved in water at the rate of 1 ounce to a gallon and let it fast there for 2 days or so when it is sure to recover. Another general cause of disease is the presence of parasites. Fish sustain relatively to a great amount of parasitsm than any other vertebrate class. Of the parasite infected fish, some are microsopic and are known to science as Myxosporidae and Myxobolidi. These are dangerous causing fatal diseases. Detection, diagnosis, treatment and cure are most difficult. Once the epidemic is on, the water should be netted and the fish destroyed (not buried but burned), so that no parasites should be broadcasted by wind or rain. Myxobolidi causes small pox and characterised by discoloured patches, lumpy tumours on the skin especially of carps and other fresh water fish. The presence of microscopic parasites causes loss of fat and weight for example in fresh water shark and in others affect the balance so badly as to render the fish unable to maintain its equilibrium.

Another group of parasites is worms which attach themselves by succers or spines the gills,

intestines or in the viscera. Result is the hosts are deprived of the food or emaciated and get consumption.. The young ones of certain tape worms of cause irritation and stimulate the flow of mother-of-pearl around the encysted work and thus cause pearl formation.

Fish lice. They are found sticking to the gills, mouth etc. In ponds fish rub themselves against submerged vegetation and stones etc. In the aqarium, sand and gravel is provided for this purpose. Fish swallow sand and blow them out through the gills along with the lice. Salt bath for two or three days is the general remedy.

Egg bound. Common disease that confronts every pisciculturist is egg-binding. Carps in stagnant waters generally suffer due to this. When there are no optimum conditions to breed, the eggs cannot be discharged. This is the reason that carp should not be grown in a pond for more than 3 years, otherwise all will die. In hatcheries, farms and aquaria, dead fish are found on autopsy, to be egg bound or to have suffered from fatulence. In the stomach, distension of the gall bladder, inflammation of bile duct, or intestine, faulty degeneration of the liver of thyroic tumour is found.

Fungus. This induces gill fever. Fungus growth attacks eggs and also adults if they are injured by dropping of scales, injury or bruise to mouths while conditioning. This is a deadliest enemy and spreads to other fish. This is the reason that when

conditioning and handling the fry every care should be taken to see that they are not injured. Treatment.— Salt bath or application of much diluted formulin.

Tanks require thorough cleaning by pottassium permangenate solution for at least 2 hours. Fungus attacks the fins of fish especially trout and rarely Gourami. Fungus appears as a tuft of white threads Salt water bath 3% solution for 5 to 20 minutes gives relief. Patches of skin overgrown with fungus when rubbed gently with cotton soaked in 1 to 2000 parts of copper sulphate solution or a weak solution of common salt in venegar or iodine effect speedy recovery.

Asphyxia:— Transfer them to oxyginated waters and give them mild salt bath.

For bacterial diseases give pottassium permangenate solution bath 1 to 50,000 or copper sulphate solution 1 to 25,000 and epsom salt bath.

In chemical treatment care must be taken that the fish must be dipped just below the gills.

Bruises:— Silver nitrate, kerosine or aluminium sulphate should be touched on the spot.

Eyetrouble:— Boric acid or a solution of 9 parts glycerine and 1 part iodine.

Air Bladder Troubles:— This is indicated by loss of equilibrium. It will tend to lie on its side or on back or floats upside down. Squeeze the fish and message until the air is expelled.

Wounds and Cuts, and torn scales.

Touching with silver nitrate or iodine and a solution of Potassium permangenate in sea water 1 to 1000 grammes.

Skin diseases:— Inflamed areas on sides and the appearance of white loam mass. Potassium permangenate in fresh water 1 to 1000 gms. or touching with turpentine. The best remedy is to seggregate the fish.

Sterilisation of ponds. For many of the diseases sterilisation of the tank is best remedy. To treat the pond when affected by parasites, the fishes should be removed to another water and the tank de-watered and desilted. A thin layer of calcium oxide (quick lime) powder should be spread on the bed ÷ refil after 2 or 3 days and wash out the lime. Repeat this process at least for 2 times and then allow the tank to dry before it is refilled and fish reintroduced. If it is filled with chlorinated drinking water, the parasites gradually die and drop down.

Enemies of Fish.

Other, Crocodile, predacious fish, tortise, frog, snake, crab, cormorant (water crow), king fisher Pond herron (water foul), Dab chick (small bird) birds of prey, duck, crane, are all the enemies of fish.

Ducks should not be allowed at the egg or fry stage. It is not harmful at the stage of finglerlings and bigger fish.

Frog attacks eggs and larvae. Snake any stage. Daphria and other insects.- Small insects attack egg stage. Fungus growth.- attacks eggs and adults if they are injured. Water [pollution is another enemy. Sewage - unless properly diluted and allowed is very risky. As there will be also likelihood of bacterial in the sewage, better to avoid it.

When ponds are dirty, old, choked with debris vegitation, the fish will die. On a rainy or drizzling day when the sun is not shining, it is very dangerous in muddy old ponds. Due to lack of sun shine, oxygen in the water will be very limited. The carbondioxide released by the plants will mount up and as it cannot be nutralised. Fish will come to the surface and the limited oxygen contained in the top layer taken off and the whole pond will become acidic, since the plants also release carbondioxide. Hence there should be no excessive vegetation. Seasonal tanks do not suffer from the excessive vegetation since their drying up the bottom will be corrected. Muddy or oozing swampy ponds are detrimental to fish life especially on a cloudy day for want of proper photosynthetic action. A little bit of saline nature is very good for quick growth of carp. 0.02% of common salt is best, if the water do not contain it. It is also good for fish to get rid of the parasites. Salinity enriches the planktonic life.

The Otter is doubtless much more destructive than the crocodile, because it is more numerous and because it kills and tastes a large number of fish than it eats. Otters can be trapped by what called Otter traps. They can be baited. also with eggs

filled with lime or by offering rewards. The best way to protect the fish farm is to erect wire fencing around. Trout hatcheries and nurseries are provided invariably with such fences.

Crocodiles:- Can be baited with big sized hooks and dead bait. These may also be poisoned but as far as possible this must be avoided so that the waters may not be poluted.

The king fishers are numerous and these are of 4 kinds, the biggest being the size of a Jay bird. They live on fry and small fish especially the surface feeders, but their bright plumage is their ruin.

Cormorants also hunt fishes and these birds are made use of by some people especially the Japanese and it is said that one single hunter can manage 6 to 12 birds at a time. Rings are attached to their necks and thrown at fishes. When the bird catches fish, it cannot swallow it for the presence of the ring and it will be hauled up by the hunter by means of thread attached to the bird.

Tortoises are also great enemies of fry and small fish. They can be eradicated by hooks.

Frogs do some mischief among the fry but they have themselves many enemies. In water, the murrel feeds entirely upon them, generally lying close under the banks for this purpose. On land mongoose, snake; kites, crows and paddy birds assist in suppressing them while water snakes follow them in both the elements. Frogs should be carefully excluded from an artificial pond and nurseries.

Ova have their enemies here or elsewhere. The small water insects devour them in large numbers. Eggs and fry of opheocephalus are distroyed by minute insects. Fungus in artificial hatcheries is a common and most dreaded enemy of ova. Frogs, fishes and ducks also do havoc to ova.

About the exclusion of domestic duck from fish pond there seems to be a difference of opinion. Some western pisciculturists seem to have no objection but it is quite safe to exclude them since at least the demursel eggs become victims to them.

Men search in the rivers for hillocks where-in spawn has been left, other the ova and make cakes which are considered a delicacy. The eggs of barbus dubius are poisonous and they cause diarrhea.

Predatory and cannibal fishes like murrels and trout should be netted and seggregated.

INLAND FISH FARMING.

Chapter III.

Construction and conversion of ponds.

Construction of fish ponds in a fish farm.

DIFFERENT TYPES OF PONDS.

HATCHERIES.

(a) **Natural** :– Natural Hatcheries should be about 2 feet to 3 feet long; 1 foot to 1½ foot wide; bunds rising up to 12 inches, water level should be 4 inches to 8 inches. Continuous circulation of water is essential in hatcheries.

(b) **Artificial**:– Artificial hatcheries are employed with advantage to hatch certain species of fish eggs, e. g. Trout and Hilsa. A series of clear wooden troughs are used in trout hatchery. Care should be taken to prevent fungus growth. Eggs are placed on grills which are submerged into the troughs. 3 to 4 weeks are required for hatching out the trout eggs; during the period dead eggs must be removed then and there. 56 degrees Centegrade temperature is maintained.

Hilsa hatchery: An overhead tank with a constant supply of water with a pipe system to supply a number of Macdonald jars bearing hilsa eggs inside for hatching is required. The whole pipe system should be insulated with straw and if the temperature is stll higher, wrap the whole length of the tube with pieces of gunny. Mineral water not suitable. River water well filtered would be the best.

Nurseries: 20 feet into 40 feet into 2 feet (cubic) area is good. For carps more extensive and deeper ponds are required. The maximum depth being 3 feet. Carps are quick growing and more food is necessary for them consequently during nursery stage. Shade is essential in case of nursery. In the absence of natural shade, artificial shades are to be provided. Fish runs are to be provided for nurseries. They may be inset or long drawn out. The object in providing fish runs is to feed, exercise, capture of the fry and fingerlings and also for the earation of the water. The bottom of nursery must be clear unless it is manure. To manure a nursery, put the cotton seeds crushed in a basket and place it in a corner submerged.

Vegetation like mycrocostic (green granular algae), Lemna, Wolfea (duck weed), Pestia etc., may be provided in the nurseries.

REARING PONDS. From the nurseries, when the fish reach fingerling stage, they are removed to rearing ponds. Maximum depth should be 3½ feet for a rearing pond. Fish can be retained there till they attain marketable size. For reception of young fry a comparatively small and shallow tank should be selected. In the driest seasons, the tank should be dragged several times and fishes other than those under culture should be scrupulously removed. The bottom should be clear of all rubbish and weeds. Gravely bed is very conducive for carps to grow quickly. Planting of stakes here and there will help the fish to rub their bodies against and get rid of external parasites. Water should be clear and free from mud. Not more than 200 fry should be put into every 100 cubic feet of water and quick growing fish like Catla and Rohu, one per square yard of surface area is usually enough. Great care should be taken in handling fry so that they may not be wounded and bruised during stocking. The fry live almost entirely on minute animalcules like crustacea, copepods, protozon etc. and very small larvae of insects. It is not possible to feed the fry in their early stage with artificial food but nitrogenous matter of any kind is likely to stimulate the growth of minute animalcules on which fry subsist. It is therefore, admissible to throw into the tank the remnants of food from the table as well as the refuge from the kitchen. Care must be taken however, not to over do this as the decomposing animal and vegetable matter may pollute the water to such an

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extent as to destroy the fry. The rearing tank should be carefully watched from the time they are stocked. If everything goes on well, the young fish will come to the surface regularly every morning at an early hour and continue swimming just below the surface till 9 a. m. and then they should go down. This they do to warm themselves after the chill of the night and hunt for their breakfast animalcules. This is the proper time for the anglar to fish in tanks and ponds. If the fish do not go down when the sun is well up it must be presumed that there is some thing that they dread in the tank; i. e., there is either an enemy that they dread at the bottom or there is not sufficient food for all of them in the water or that there has been a transformation in the character which they do not like. If it is a case of decying vegetation, or some other pollution responsible for rendering the water highly acidic, tank bottom has to be cleaned by de-watering, but where it is not possible or admissable, siphon out the bottom layers of debris (siphon described by Dr. H. K. Mukherjee – of the Calcutta University – appended at the end of the chapter is considered good for the purpose) The remedy in such a case is to drag the tank at once with a net and assorting of all fish to see if there is any predaceous fish or any other enemy below. If so the fry would be alright after the removal of the enemy. If no enemy is discovered then some of the fish should be removed to another tank to remove congestion and if even this does not prove efficacious, it must be presumed that the water is not suitable for the growth of the fry. If is generally found sufficient to drag the tanks several times as thoroughly as possible to after the character of water for the benefit of fry.

STOCKING PONDS. Stocking tanks would be of medium size and not as large that they cannot be dragged by ordinary dragnets. The best thing is to increase the length of the tank than the breadth to extend the pond. There should be atleast 6 feet of water in the driest season. Water must be clear and free from mud. Ordinarily, fish will thrive sufficiently well in almost all tanks so long the water is clear. It would be remembered that the carp cannot see through muddy water and every care should be taken so that the water is never made dark with sand and ooze. There should be plenty of space to swim about freely for the fish. As in the case of rearing tanks, no artificial direct feeding is recommended in this case also. The adult carp also lives on microscopic water fauna althrough a few vegetables along mud are found in their stomachs. But this is attributed to the involuntary swallowing at the time when the carp sucks in water fauna. It is therefore, not necessary to put into the water cooked rice, parched rice, flour balls or other starchy matter but as recommended in the case of rearing tanks, bathing of men and cattle, washing of clothes and dirty plates and the throwing in of kitchen refuge or offal are recommended as they supply sufficient calcareous and nitrogenous matter for the growth of natural food of fish.

MARKET PONDS. Market ponds are those where fishes are kept for marketing purposes. They are so called for the following reasons:— 1. The case with which fish can be grown in any quantity and 2. the partiality of the public for the fish of this pond. In clean ponds the muddy flavour of the fish can be made to disappear. In case of

sewage fed ponds (rearing ponds), the public may have an objection to take fish from such a pond. This difficulty could be also overcome, if fish are transported to market pond before sale.

BROOD PONDS. A pond in which fish are expected to breed is called a brood pond or a breeding pond. A constant water level in these ponds is desirable at all times and must be maintained during the breeding season. In case of Etroplus 2 feet to 4 feet depth is required. (Breeding season is twice a year from May - June and November - February) For Gourami a depth of 3 feet is required. (Breeding season twice a year from February - March and September to November). Mirror carp 3 feet (Breeding season November to February once a year).

The ponds fed by river systems receive a more or less continuous supply of water and the required flow in the fish form could be so adjusted as to maintain a uniform level at all times. In case of the majority of ponds this is not so feasable as the supply depends on surface rain water or subsoil springs. For the maintenance of desirable level in such ponds, tube wells may materially assit, failing this, the only alternative is to store water in a spare pond during rainy season and to draw water therefrom as may be required. High temparature in season is necessary in brood and receiving ponds. If the water is cold, at the source, the fault must be corrected by reducing the inflow to the lowest quantity that will mantain a uniform level, thus allowing the maximum absorption of warmth from the sum and air. A temparature of 60 degrees F. in the brooding pond during the spawning season is desirable.

SUITABLE SITE FOR FISH PONDS.

If a gravity flow of water is contemplated the fish pond must of course be located below the level of source of supply. If the site is perforced to be located in a swampy area subjected to inundation, flood banks are to be erected around the pond. Porous soils are to be avoided if possible not only because of the large volume of water required to replace loss from seapage but because they are usually sterile. Swampy lands, old water courses and catchment basins of years standing are the best and most productive soils as they possess the required fertility and contain seeds for the early development of profuse vegetation and animalcules. Ponds located in such soils will maintain their water levels with a minimum inflow. Aside from the ideal lands of alluvial deposits, cley loams are of first choice being most nearly impervious to water and quickly responding to the efforts made to establish their fertility. Sandy loam being the most prevelent, is probably the most general soil in use for power construction, while some difficulty may at first be experienced in making it retain water. This is over come in time by accumulation of decayed vegetation. Its fertility is good and if allowed, produce a sufficient supply of natural food. Even sand and gravel mixtures may be made to hold water and brought to fair productivity by increased expenditure in construction and by the application of fertilisers. It is very desirable and also essentail that ponds be so located and constructed that they may be entirely emptied of water at certain seasons.

Ponds are drained to render easy 1. removal of objectionable spices; 2. killing excessive vegetation

and 3. reducing the stock and assorting fish. A number of small auxillary ponds will always be found advantageous in fish cultural work.

UTILISATION OF WASTE LANDS.

The aim of the successful pisciculturist should be to utilise the natural and favourable water areas which at present are being put to no use. The presence of springs, lakes, flowing wells, or adjacent streams are all leading incentives to a fishery project and suitable sites for the construction of ponds especially if at present unremunerative, should make their use for such a purpose desirable to the thrifty agriculturist, after full comprehension of their possibility in a cultural way. Ponds intended primarily for the cultivation of fish may be conveniently located for watering the stock or flow therefrom may be utilised for the irrigation of land. In many sections of our country artificial ponds on farms are an absolute necessity to serve one or both the purposes and by a merely nominal expenditure such water areas may be utilised adequately for the growing of fish without interfering in any way with the original use for which they were intended. There are many cases in which drainage or marshy or flooded areas would not return an income commensurate with the cost of the work. As in such cases, the lands might be made productive by utilising them for the production of fish. With respect to such water areas it may be stated that if drainage is provided for; the pond bed cleared off debris and the site protected against inflow of surface water, if in short, complete control is effected, natural water areas will possess many advantages over artificial constructions.

WATER SUPPLY. The volume, quality and temparature of water in fish farm is a matter of importance if maximum results are to be obtained.

Sources of water supply for ponds

Springs are the most dependable of all the sources of water supply requiring the minimum expenditure in preparation and being the least subject to out side influence. The presence of injurious mineral substance usually can be deducted without expert analysis, but the amature fish culturist may be surprised to learn that so called pure water often carries abnormal proportion of oxygen, and nitrogen gasses in quantities inimical to fish life. This may be due to sub-aeration or super-aeration and the results following the use of such water will be as disastrous in the one case as in the other. This contengency and the requisite of high temperature makes precarious the embodiment of springs and wells within the pond bed. The flow from many springs is so obstructed through the tramplings of live stock or from other causes that they emit only a small proportion of water, available near to the surface. In such cases, the supply usually may be increased materially by sinking 2 foot length pipes over the bubble and removing the encased earth. Several such pipes in a promissing area often will result in an astonishing increased inflow. When the cost is prohibitive, however, the better course will be to excrete the site and wall it with rock and concrete.

The chief objection to creek or river water as supply for fish pond is the great quantity of mud

and debris carried during the flow and excessive cost of effecting measures to prevent its introduction into the pond. Streams subject to high floods are totally impracticable as a source of supply until those of lesser floods can be utilised only after a considerable initial expenditure and much vigilence will be entailed in their use as large and continuous deposits of mud in breeding ponds will ruin any eggs present and recently hatched fry. Further, protracted incoming of soily water will retard and some times prevent the growth of the aquatic vegetation so essential to ponds and fish culture operations. It is also imperative that undesirable and predaceous fishes be regorously excluded from the ponds and will be impossible to accomplish this if the water supply is beyond control during certain periods. When the source of supply is a lake, the difficulties referred to above are not encountered, the lake water demanding less attention owing to the absence of currents. Uncontaminated open waters have many advantages. Their temperatures are seasonal; usually there will be no abnormal gasious constituents to be corrected. The plankton contained there-in forms a valuable addition to the natural food supply in the pond.

Wells, both flowing and power lifted are successfully used in some sections for the cultivation of fish. Before increasing the expense of constructing ponds to be supplied from such a source, however, it will be advisable to test the water thoroughly in order to demonstrate its fitness for fish culture.

Rain water. (Surface drainage).

Another class of ponds available for the propogation of fish known as 'SKY PONDS', wholly or partly dependent upon local precipitation as for their supply of water. Such ponds are invariably profuse in the production of fish food and for this reason, would be ideal were there an auxilliary supply of water adaquate to maintain constant surface levels during the initial season and a fair depth throughout the remainder of the year. In the absenae of this reserve, many such ponds become virtually dry during the periods of draught. Ponds entirely dependant upon precipitation and surface drainage for their water supply must necessarily be located at a lower elivation in order that a surface drainage from surrounding lands may be taken advantage of land depressions in swampy lands are desirable sites for such ponds.

VOLUME OF WATER.

For one acre pond wheresides and bottom are of clay or rich loam a flow of from 30 to 50 gallons should be sufficient to maintain a proper water level at all times, while sand and gravel soil untreated may require double that amount.

HOW TO MEASURE THE VOLUME OF WATER.

Select a stretch on the stream or ditch affording as straight and uuiform a course as possible. Lay out a distance of say 10 to 50 feet; mesaure the width of the flowing water at about 6 different

places in this distance and obtain its average width. Likewise, at the same points, measure the depth of water at 3 or 4 places across the stream and obtain its average depth. Take the average depth and width of a stream, drop of a float in wator and note the number of sconds it takes to travel the given distance, the product obtained by multiplying the average width in feet by the average depth in feet by velocity (expressed in number of cubic feet per second) will give the flow of the stream in cubic feet per second. 25% has to be deducted from this figure since the surface velocity of water is in excess of the actual average velocity. The required flow of water into the pond must be sufficient to replace loss by evaporation and seapage. A surplns of water is preferable to a shortage, especially in case of fish like Gourami. An amount just short of over flowing the pond is the ideal to be obtained and it is desirable to avoid a current.

POND CONSTRUCTION.

When practical, ponds should not be less than one acre in surface area. Those of smaller extent will promote fish but not yield adult food fishes of the larger species in sufficient quantities. The ponds should be built up rather than excavated and the water level there in, will be higher than the surrounding land.

The exact mode of construction must depend largely upon local condition such as the presence or absence of favourable land contour (level), the nature of the soil, proximity to stream channels. Natural draws or ravines involve least expenditure in their

adoptation to fish farms as two and frequently three sides are already formed so that an earthen embankment connecting them will complete an enclosure. The bottom of the pond should be shaped to drain to central pond and from there to outside. The method of constructing pond embankments is governed by 1. the topography of the land; 2. the character of the soil and 3. The volume and pressure of water to be confined. All laid embankments should be atleast 5 feet in height; and the sides sloped not less than to 2 feet to each foot in height. For example, a six-foot fill embankment should be 30 feet wide at the base and six feet at the top. Prepare the foundation by ploughing the site of the embankment after first clearing it. As an extra precaution against seapage, dig a trench 12 inches deep along the mediam line. This will form a breech or set off between the original ground and make construction strong where there is a point of natural weakness. The filling in the bed should progress by layers over the full width and length of the bed as a continuous operation rather than by sections, other wise the completed work will later develop cracks by reason of variation of material and compactness. The shape or outline of the pond is immaterial as to a considerable extent fish will adopt themselves to existing physical conditions.

It will be found convenient when draining the pond to have shallow channels 6 inches deep and 15 inches wide, at the head of the drain radiating to all parts of the pond bottom. Fish will follow such channels as the water receds and may be removed with less danger. Remove all projections from the pond bottom that might interfere with netting

operation. Plough the entire bed and level it before turning in the water,

Sandy loams are most uncertain. They require time to become thoroughly saturated but will improve in this respect from year to year to accumulating deposits of decaying vegetation. It is an excellant practice when first filling newly constructed pond with water whatever the nature of the soil. Constant soiling and irrigating is very effective in cementing open cracks and crevices. Very porous soils may require the addition of a layer of clay before they hold water. From 2" to 6" of stiff brick clay on the entire bottom and up the sides well above the water line will hold water well. The bottom prepared as above will hold water for the most open ground likely to be used.

OBJECTION.

The only objection to clay is its general sterility but this may be corrected by another layer of rich loam. Twelve or more inches of coarse stable manure and even clean straw well trampled into the pond bottom is a successful remedy for seepage. A good set of grasses (sedge grass) around the entire pond especially at the water line is the best preventive of wave washing and encroachments upon new fills.

If the bottom is such, that strong currents are present, piling rocks, stones or debris or other reinforcements will be necessary at the points of the greatest exposures.

Summerising the construction of ponds, the following features must be provided for:- Water tightness so that a small inflow will be sufficient; a constant water level especially during the breeding season when and where the fish may nest, a fertile bottom for the growth of the aquatic plants upon which fish food depends.

SUB PONDS AND SHADE SCREENS.

Seasonal ponds dry up in summer. The conditions of draught can be over come by 1. Providing shade screens in the form of pondals and ferry hanging over the pond which can be adjusted according to the movements of the sun; 2, digging a sub-pond deep enough in the centre of the pond.

AQUATIC VEGETATION AND ITS VALUE IN THE CULTURE OF FISH.

The advantages of aquatic vegetation are many. 1. It serves as food; 2. harbours lowest form of animal lives, each advanced in the scale of life form food for higher forms as fish. It plays an important part in purification of water taking carbon dioxide gas liberated by decomposition and giving out oxygen, thus preventing the asphyxiation of fish and act as corrective of many abnormal characteristics of individual waters; 3 gives shelter to fish against enemies; 4. furnishes shade on bright and warm days; act as good soil binders ; 5. prevent turbidity from casual disturbances.

Aquatic flora varies with locality and altitude and depends on the chemical nature of waters also. Aquatic Plants thrive best in waters of lime stone

origin. Plants of filamentous character are preferable to the large and spatulate leaves as they provide large surface expense for the exchange of gases. On account of their shallow rootage, they can be easily controlled and also they offer least resistance for netting operations. Much time and trouble are often required to bring about a profuse growth of aquatic vegetation but after a pond is well grown with such vegetation more care and labour are required to keep it under the control.

ERADICATION OF EXCESS VEGETATION.

An efficient method of removal of excess vegetation is by raking, the worker standing on the bank of the pond if it is small. The most effective means of control is by netting with fine mesh nets. The chemical method should never be applied in fish pond. Species like water hyacinth should be dragged to shore, dried and burnt.

FORAGE PONDS.

In fish ponds where it is desired to grow highly predaceous fish like murrels, eels and catfish, we have to provide for them forage fish ponds where plenty of minnows are grown and put in the fish farm. This will prevent the predaceous and canibalistic tendency among the fish under culture by feeding themselves on these minnows.

IRRIGATIONAL SOURCES OF NATURAL WATERS.

The scarcity of water and paramount demand on the available water sources made by agriculture rendered inland pisciculture in India an industry of secondary importance. Nevertheless, there are

innumerable water areas in lakes, tanks, ponds, ditches, canals, streams, lagoons, back waters, salt creeks etc., which are at present put to no use, but suitable for pisciculture as an adjunct to agriculture. Even tanks and ponds primarily intended for agriculture can be conveniently adopted for the cultivation of fish at a nominal expenditure whithout interfering in any way with the original purpose such as irrigation or as sources of drinking water for man and farm stock. In the method of Indian Pisciculture, Japan suggests certain chief and immediately possible methods open to the poorest man who owns a patch of water; to every village which has a tank or pond, as well as to the owner of many thousand acres of paddy fields and canals.

WHY CARP SHOULD BE CULTIVATED.

Under the head of carp culture, it has been seen that in from 4 to 5 months at the most, carp of 1½" to 2" long placed in the Japanese paddy fields increased to 8" or 10" and though still immature are quite marketable while culture ponds produce a large out turn per acre. In India or elsewhere, carp is one of the handiest, most prolific and most rapidly growing fish and form 60% of the fresh water fish. Madras conditions indeed are good for carp which for thier most rapid growth require a temperature of about 80 degrees F. with of-course plenty of food, and thrive well in shallow water in most of the canals, tanks and ponds of the presidency. Carp especially in the tropics 1 grow rapidly into a good size; 2. practically omnivorous; 3. very cheap to feed on artificial diet; 4. stands

transport, better than any other fish and therefore is suitable for cultural work.

TANKS: Under the heading reservoirs also may be included. There are very numerous sources for tanks but the bulk of them contain water for a few months in a year while most of them are precarious in supply. But such as they are, they should be improved as food sources by direct cultivation and should not be allowed merely to grow a natural crop or to go fallow. For seasonal waters, the best fish are peak growing carps like catla and rohu. It is with this view that the Madras Fisheries Department is gradually acquairing of inland waters to improve them by annually stooking them with fast growing fish like catla and rohu. Rohu not being a Madras fish is being slowly introduced from Bengal in small consignments annually.

BUNDH TYPE OF TANKS.

They are hilly, rugged and wild. In 1908, Sir K. G. GUPTA recommended the bundh type of tanks for carp breeding. It is a pond and canal simultaneously. It simulates a river in having flowing deep pools in its bed. Attempts to induce carps to spawn in tanks were made since 1908 without success. Later on brood fish from rivers were given up in favour of those from tanks as the former will take some time to recover from the shock from netting and transport and to get acclimatised in the new environment. A series of experiments in spawning of carps have been done with success in Bundh type of tanks and this is playing the part envisaged by the pioneers in carp breeding in confined waters in Bengal and elsewhere.

DEFINITION OF BUNDH TYPE OF TANK.

A bundh is a shallow trough like structure formed by raising embankment on the lower side of a natural depression at the base of some elvated or undulatory land (catchment area); an outlet being left at one end for the over-flow of the surpluss water. Serves usually for storing rain water for irrigation purposes as well as carp culture. Most of the bundh type of tanks dry up completely every year soon after the winter. During rains water from all sides of the catchment area collects in the bundh which fills rapidly. In perennieal bundhs carps are grown and kept throughout. In seasonal bundhs breeders are brought from other sources and kept there during the rainy season. Bundh type seasonal ponds are very good for breeding carps at will.

CANALS.

Omitting Tanjore and other deltaic systems, there are under the Kistna, Godavary and Kurnool-Cuddapah system and Ellore, about 1072 miles of main and branch canals all navigable, besides above 5,000 miles of tributories exclusive of field channels in the Madras presidency. The body of water contained in the main and branch channels at any given moment must be above 2,000 million cubic feet and the volume of water let into them during the irrigation season averages about 3,00,000,000,000 million cubic feet or eleven thousand million cubic yards. This vast body of water is probably full of fish food since the rivers drain forests and districts in their course, while the sides of the canal provide a good deal of vegetable life and consequently

shelter small animal life of very rapid growth. The total area of this water at an average of 60 feet in width is some thing over 8,000 acres, but this in no way expresses its productivity since the water is continuously changing being river water and bringing new supplies of food. These waters will support for the time enormously more fish than an equal area of a tank or a lake where water changes are only seasonal. This great volume of water which is now not utilised as a source of fish production could be profitably used for growing young fish especially of the carps. These canals are full of water only during the irrigation season when most of these carps breed in the rivers. They get naturally stocked and if protected till the close of the irrigation season by applying legislation, we can raise a hand some harvest.

PONDS. Under this heading come the very numerous class of tanks not used for irrigation. Generally they are not embanked reservoirs but excavations such as garden tanks, temple tanks and drinking water and bathing tanks in towns and villages. Temple tanks belonging to religious institutions, though contain much vegetation and food metorial, are not at present available for pisciculture because of religious sentiment. They serve as very good nurseries and with skill and propaganda on the profitable nature of pisciculture, the authorities can be convinced of the importance of the tanks and they can be taken over. Similarly municipal tanks can be stocked for angling purposes alone. Village ponds however, can be more freely utilised. They are extremely numerous and when deep, will keep a supply of

water throughout the hot season. Into these ponds drain water from the village lands viz., the paddy fields, the house site and cattle sheds etc, while the cattle habitually bathe in them, hence the supply of food suitable and agreeable to fish is particularly abundant. These can be conveniently used as fish farms only on co-operative basis. These small ponds could be deepened to at least 6 feet with a deeper pit in the middle. Such ponds will seldom go dry and would support a large weight of fish for village sport and food. This will be suitable subsidiary occupation for the villagers during the non-cultivation season. The ponds could be stocked with few fry from the nearest natural stock. Ponds of this character shaded by fruit trees thriving on the soakage from the ponds and in turn providing food for fish by their leaves and insects falling from them. This would supply much needed village want in water for cattle, shade and food etc.

WELLS. By these are meant the great irrigation wells of Coimbatore and other districts. In Coimbatore, a district almost of minimum rainfal inland and far from marine fish sources, there are some 80,000 of these wells within averge area of 10 sq. yds. (about 50 make an acre). 1,600 acres of water is available which is in many cases is perinniel. These wells naturally contain a certain amount of fish food in and on some aquatic plants found in them and in other small life, but it would cost practically nothing to supply food such as frogs, warms, insects etc., from the fields so also surplus food from house and cattle shed will be useful and cheap. The return in fish would be astonishing if each well provided an annual weight of two stones,

80,000 well will furnish 1,000 tons fish of worth about 3 lakhs of rupees.

PADDY FIELDS. The growth of fish in fields in Japanese fashion will be a matter of great experimental importance as nothing can be predicted as to their financial results. In fields producing a single crop of rice and well supplied as in the deltas with practically unfailing water, the rearing of carps should succeed at least as well as in fish farms. Fry may be seen even now in large quantities in the fields having entered there through irrigation system and some of these escape immediate capture and grow to appreciable size. But the vast bulk are captured at once by fine basket traps from each field where fry are found naturally. As in the Tanjore and West Coast fields, it will only be necessary to substitute bamboo gratings for basket traps at the exits of the fields so as to simply detain the fry in the field instead of sharing it. When fry are not naturally found it will be a part of the stocking operation of the Fisheries Department to supply suitable fields with fry. Whether small fish thus stocked would escape the numerous enemies of fish like the paddy birds, king fishers, crabs, snakes etc., is ofcourse an important question. As an answer it can only be said that it is not admissable to stock such paddy flats where the depth of water is below 6 inches. In he absence of any natural depression in between the paddy flats for collection of excess water, it is advisable to dig one and provide it with some vegetation for the fish to resort whenever the water level decreases or when there is

danger from enemies. Tanjore, Thrichy, Kistna and Godavari, and East Coast in general as well as on the west coast, paddy cum fish culture will be a profitable one.

ESTUARINE FISH FARMING.

This is practised in Europe since a long time. Hifous first designed a pond for marine eel which was very famous wth Romans. Comachhio on the Adriatic coast have got very good brackish water fish farms almost from Roman times. Romans are the first to start fish farms and they designed a pond for the sea eels. Slaves were thrown into these tanks to serve as food for the eels. In later days, from being mere ponds for keeping fish alive till needed for the table, these developed into fish breeding ponds. At present over 1200 tons of fish, 800 tons of them eels are annually captured at Cammachhio.

In the Far East, Japan has practiced marine pisciculture for a very long period. The cultivation of eels and mullets is extensively carried on. Three ponds near Tokyo with an area of 6 acres visited by Sir F. A. NICHOLOSON are reported to produced 20, COO sterling worth of eels, 23,000 sterlings of carp and a large number of mullets per acre. To-day estuarine fish farming worthy of the name is limited to Italy, France, and Cammachhio where the rearing of estuarine fishes in ponds and lagoons is carried on extensively. (Refer Madras Fisheries Bulletin No. 56 for detailed study).

In the east at the present time by far the most famous are the chanos farms of the Phillipins and

of Java of the Dutch East Indies where several thosunds of rupees have been invested in this industry.

The lagoon of Comachhio is a vast salt water lake irregularly circular in out line, situated in the southern section in the belt of the Po river. The Arcachom fish farm of the France is a basin margined along many sections of its shore by low lying marshes. Any lagoon or a back water can be converted into a marine fish farm be erecting high embackmen and sluice shutters taking into account the tides of the area into considerrtion. Stocking of these waters are done by taking advantage of the high tides with the help of the sluice shutters.

SCOPE OF MARINE FISH FARMING IN INDIA.

Waters available are suitable for marine fish farming fall under three heads.– (a) Back water (2) Salt pan channels; (c) Estuarine or deltaic marshes.

CHAPTER IV.

FOOD OF FISHES.

Vegetation of ponds and lakes consists of rooted aquatic plants and also rootless ones and minute floating unicellular organisms which collectively receive the name PLANKTON.

PHYTOPLANKTON.

Many of the minute floationg plants are too small to be discerned by the naked eye but when in great numbers they give the surface of waters distinct greenish yellow tint. The animals of ponds may be grouped into 1. those floating in the waters; 2. those lurking in the weeds or under the stones and 3. those burried within the mud. First group is called the zooplankton. They are small though most of them could be made out with the naked eye and comprise the water flies and the related forms. The inhabitants of the weeds and stones, are the larval stages of cadis flies, stone flies and dragon flies, all of which are aerial at the adult stage and also the snakes, shrimps etc., which spend their whole life history in the water. In the mud are found the midge, larvae of black worm and mussels etc.

PHYTOSYNTHESIS.

Plants are able to build up water and carbon-dioxide into sugary starch using the sun as the source of energy (moon light helps also in photosyn thesis). They also need proteins to build up. For

meat they require certain elements, such as nitrogen phosphorous in compound forms as nitrate, phosphate etc Water is present in unlimited quantity and it is seldom that there is insufficient carbon-dioxide to fulfill the requirements of the plants, but the amount of nitrates and phosphates and similar substances is often extremely small and it is the supply of this salt which limit the amount of life produced in any body of water. Algae living either free in the water or attached on the bottom to submerged object provide the main source of food for the zooplankton and other small animals. These are eaten direct by the young of most fish and by some fish through out their life. They are also eaten by the larvae of insects which themselves are directly or indirectly provide food for fish: thus fish depend ultimately on the plants for food; these plants depend on the amount of certain salts present. Making good difficiencies, in the natural supply of salts is often the most satisfactory work of increasing the productivity of lake or pond. Most of the coarse fish food is to some extent vegetable matter but it seems to be essential that a good supply of animal food should be available if we are to show satisfactory growth of first group varieties such as carps, mullets and chanos, catfishes, murrels, eels etc.

Different species of fish have different feeding habits. Carp for instance feeds mainly on or near the bottom. Tench takes snails more readily, some species of fish feed on different organisms at different stages of life. Some animals are of little value for they are unpalatable or because they live in situations where they are not available to fish.

Others such as water beetles are undesirables because being carnivorous, they compete with the fishes for food and many even prey on the fish fry. All insects which are aerial as adults, consume substances available in water and when they emerge and fly away they remove these substances from circulation. Therefore, animals which are aquatic throughout their life are preferable. Snails and shrimps may profitably be introduced to form fish food.

BOTTOM WATERS.

The nature of the bottom is extremely important in the biology of the body of waters. Large numberse of plankton organisms, some of the insect larvae and fish die and fall to the bottom of the pond. Their bodies decompose into simple salts from which they were originally built up. Good bottom has an advantage that the products of the decomposition are absorbed by the bottom soil and are given out slowly. This property is of first importance in the case of fertilisers. Bottoms may be divided into three types:-

1. Inorganic bottoms of sand, gravels and clay. This type is poor. It may be improved by the application of stable manure or sewage.

2. Muddy bottoms-A mixture of organic matter from the dead bodies of animals and plants and inorgnic matter in a fine state of division (silt) which is most productive.

3. That formed by the accumulation of vegetable debris and which has not decomposed.

This kind of bottom is barren, it should either be removed or should be made to decompose by addition of lime.

SOIL CONDITIONS.

Nature of dissolved substances and temperature are factors important in the cultivation of fish and vary greately in different parts of country; so it is difficult to lay any general rule by which the productivity of a body of water can be assessed or controlled. Calciums important as a constituent of the fish food. The lowest concentration of calcium for really good prouction should be ascertained with reference to a given body of water. If the natural food supply in a pond is limited and fish stocked in it are likely to exhaust it sooner or later, unless the natural food supply is increased by manuring or addition of direct food. A much larger stock can be raised in the comparatively small pond by increasing food supply. Besides sunlight, oxygen and corbondioxide, the most essential substances for organic productivity are soluble salts. Nitrogen phosphates with traces of calcium and potassium which can be supplied by adding the following organic manure which is rich in them.

1. Animal and human excrements from yard and stable manure.
2. Sewage proper.
3 Bone preparations.
4. Decaying green manure-esp. leguminous plants.
5. organic infusion

INORGANIC MANURES.

When organic manure is not readily available, inorganic manure or fertilisers can be added. Thus sodium nitrate, phosphate rock, calcium superphosphate, lime stone etc., chemicals may be added. These will be specially helpful in drinking water reservoirs, where organic refuse cannot be introduced. The use of the chemicals should be regulated, with due reference to the palatability and quality of the drinking water. The amount of fertiliser required will depend on the local conditions, such as the soil, the volume and nature of the water, temperature etc, Fertilisers, are better applied in small quantities at short intervals than in large quantitis at long intervals.

METHODS OF INCREASING PRODUCTIVITY.

Crop of fish can be produced in a pond either by artificial feed or by natural feeding. Artificial feeding – Soya bean leaf and the waste from Silk factories are recommended as the best food for carp. Barley and maize are also satisfactory. Ground nut cake and rice bran well soaked over night will form very good nutrition and cheap food. For fish like chanos and mullets, boiled seed Potato is recommended. Trout should be given chopped fish, liver offal or horse flash.

Natural feeding:— The application of chemical fertilisers is the most feasible way of bringing this about and with proper treatment, an increase of cent percent food could be obtained. The impo-

rtant point is, that if the soil is deficient in lime, it is useless to use fertilisers, without supplying lime first, after which, organic or inorganic manure should be supplied. Phosphate is the cheap and best inorganic manure (Bone meal); addition of Potassium will be profitable. Manures should be evenly spread on the bottom and protected from current.

Lime:— may be applied in the form of ground chalk or lime stone. Slaked lime or quick lime (Oxide and Hydroxide) Cacoz may be commonly used. The later is used to kill fish parasites and also to decompose vegetable debris.

Phosphorous:— The application of phosphate manure (Bone meal etc.,) increases the biological productivity satisfactorily, *D*osage;- 1 to 1½ Cwt. Per Acre.

Potassium:— The addition of Potassium, Phosphate manure gives very good results. Potassium is usually sold as 30% salt and contains Potassium Chloride, Magnisium Chloride and Potassium Sulphate ½ Cwt Per acre is found to be the suitable dosage.

Nitrogen:— Results of manuring with nitrates and Ammonium salts are very variable and the price is also high.

ORGANIC MANURES.

Cattle manures liquid manure from farm sewage etc., may be applied to the pond with good

results and particularly recommended for newly dug ponds with inorganic bottoms 1:2 manure to loam is a best mixture.

GREEN MANURING.

Practice of green manuring, like the decayed leguminous plants is very profitable. Ponds are left dried and sown with this crop which is mixed with the soil throroughly by ploughing before the pond is refilled. It is profitable to have a rotation of fish crop and leguminous crop alternatively.

ARTIFICIAL FEEDING

Where large numbers of fish are present in a farm and manuring facilities are limited, the fish may be fed artificially by addition of direct food.

For Nurseries:-
1. Plank tonic collection;
2. Prawn dust
3. Powdered dry blood

For Large Fish;-
1. Oil cakes;
2. Damaged Cereals;
3. Kitchen refuse.
4. Silk worm paper.
5. Slaughter house refuse and other vegetable and animal matter.

(Soya beans, sweet potatoes, oil cakes and rice bran are among the cheapest and most nutriline

food material used in artificial feeding of fish. There are instances of feeding fish with barley and maize also. Soya beans may be used after soaking and crushing; Sweet Potato after boiling and mincing. Oil cake and rice bran by soaking in water. The same spot and same time should be adhered to always in artificial feeding.

Fingerlings :- Mosquito larvae forms excellant food for the fingerlings, especially of the carp variety.

The main condition in artificial feeding is that the gain in fish flesh should be considerably greater than the cost of artificial food employed. It should also be remembered that at least a quarter of the diet should be natural food to maintain the health of the fish.

In artificial feeding, it is recommended that half of the food should be animal and half vegetable. The animal food usually rich in nitrogen should be mixed with some soft clay. This should then be rolled out in thin strips and scattered along the banks. A successful fattening mixture consists of beans, pea, hemp, and the solid excrement of sheep.

THE CYCLE OF NUTRITION.

The cycle of nutrition is based first upon the organisiurs such as the animones, directly maintained by the water itself under the action of energies which pass through it. These have the capacity and virtue of collecting into one quivering flesh, those mineral substances which, themselves

inert, must constitute it as it develops and increases its volume from the germ whence each develops. The cycle begins with them and then grows progressively wider. The little crustaceans feed upon these first creatures; they in their turn serve as prey to the larger fishes, of which the diverse species, according to their size and nature, live upon one another, hunting down and devouring one another. Then these last, so far as the pond itself is concerned, complete the series. The remains of the strongest, when at last they die, decompose, break up into their elements and go back to the mineral world. Thus the cycle goes on continuously, always begun and always unfinished, bringing it to pass that all the inhabitants of the lake are more closely associated in their search for subsistence. Beneath the peaceful sparkling waters, the depths are ceaselessly occupied by hosts of Pursuers and Pursued, in this continual chase after food, in the uninterrupted consumption of the flesh of the one to build the flesh of another.

If we think of increasing fishlife by means of introducing new fry when we deem it insufficient in a particular piece of water, we must take this cycle and its equilibrium into account with its capacity and fitness. We must give due value to all these considerations and act according to the results obtained. The analysis of the plankton, as regards both quantity and quality, makes clear the line we should pursue giving us, the necessary preliminary indications on these points.

But for every evil, there is a cure, so long as we know its exact cause. The success in carp

breeding, depedns upon the nutritive capacity of the waters in which the carp breeds and this must be improved if the best results are to be obtalned. Rivers and streams are more difficult for in their case, it is not easy to ensure a continuous improvement in this respect. Before repopulating by putting in the fry, we must first study the degree and the nature of the nutritive equilibrium, and make our stocking proportionate there to. Before acclimatising a foreign species, we must consider its mode of life in its native country, and make a trial before giving it full liberty in the particular waters. Here as in every thing else, the sound method consists in thinking out things in advance, so as to make the best use of the material at our disposal.

OXYGEN, THE LIFE GAS.

Fishes like other living beings need oxygen. Because they live in water, they can find that in the water itself, absorbing it in a state of solution. Normally water contains in solution the elements of which air is made up. Oxygen being among one of them. Some of these elements it takes and absorbs until it can hold no more, whenever both air and water come into contact. The fishes use this dissolved exygen to breathe. It is essential, therefore, that the degree of solution should be adequately maintained, if the respiratory function is to be fulfilled.

In aquaria, the simplest method of keeping up the supply consists of making the water fall from above or foreing it to spread out in a thin sheet, so

as to bring it more into contact with the air and thus to produce a solution of oxygen in the highest possible proportion. Besides oxygen to breathe, the fish need a constant temperature; a temperature that is high even in winter usually be between 75° and 90° F. In order to avoid the expense of canalising water that has been first warmed, the difficulty is solved satisfactorily by planting aquatic vegetation in the tanks and letting it grow there, keeping the whole at a sufficient temperature. Several advantages are thus secured. Branches and foliage, floating in the water, from an ornamental frame, in which the fishes as they move about in all directions, unite with their environment to give a harmonius representation of natural phenomena. Again these vegetable growths purify the water on the spot and all the time, so that the water may not be renewed. Day light acting on the chlorophya of the green parts, causes it to decompose the carbon dioxide produced by the respiration of the fishes, and gradually dissolved in the water as a waste product. The oxygen, thus set free, is reconditioned and again ready to be breathed. Now the fresh waters, which differ considerably in their contents of the dissolved oxygen, vary considerably from place to place and from season to season. Their mixing with the air and purity and the vegetation on the banks, have obviously a good deal to do with it; but the temperature is the most important factor, for according to its height, the rate of solution of oxygen changes; the colder the water, the greater its power to dissolve more oxygen. Warm water is definitely poor in oxygen. The carp flourishes in warm water and the trout on the other hand, cannot get

on in it at all, unless it is sufficiently stirred by the air. The trout get on very well in swift flowing cold water which is rich in the dissolved oxygen where as carp connot at all flourish in it.

Food cycle :—

Decomposed plant or animal remains (at the bottom)

phytoplankton

↓

Absorbing abnoxious gasses and maintaining balance of super saturation

↓

Zoa plankton (living on phyto plankton) (Fairly large animals – like noequito larvae etc.)

↓

Fishes.

SEWAGE FISH PONDS.

Most people are revolted by the idea of eating fish reared in sewage. Nevertheless, the subject is worthy of consideration. Fish do not feed on sew-age. The nutrient substance comes to them indire-ctly through the intermediation of plants and small animals. Settled sewage mixed with water in large quantity in the ratio of 1 : 5 (sewage to water) is recommended. The fish pond should be constru-cted farther away from the sewage supply, and sewage should not be allowed directly over the fish, as when the flow of sewage into the pond is allowed

the fish collect at the inlet naturally and are exposed to strong sewage which is detrimental. Hence make some space at the inlet by aportioning it with bamboo tutties, so that the sewage is mixed with water thoroughly before the fish come into contact with it and choked up having been exposed to the strong sewage current.

In addition to the settled sewage water supplied to the ponds, they must be provided with a sufficient quantity of suitable fresh water to bring about the necessary dilution required to support the fish life. It is important that the sewage water should be fairly fresh and not in sceptic condition. If these conditions are maintained, the micro-organisuns will flourish, absorbing and destroying all impurities and providing food for the completion of the process. Sewage ponds are preferred for growing carps in general. According to an authority, one acre of fish pond with a depth of several feet, can receive settled sewage water from the average domestic sewage of a population of about 1,000 people. One can know by experience, how much sewage to allow at a time in the pond by judging the smell, colour of water and etc., A clear water after treatment with sewage turns green after 2 or 3 days showing the growth of rich plankton, which might disappear in a week or two, when it requirs another treatment with sewage to supply the food required. If properly controlled this will form a very good natural way of feeding fish.

Under any circumstances, No factory effluent should be allowed to be discharged into the ponds.

UTILISATION OF SEWAGE FOR FISH CALTURE IN INDIA.

Extracts from K. K. Nair, S. L. Hora and J. Fowleer's papers.

The food supply of humanity is now recognised to be an immediate problem of world importance. Renewed attention is being paid by scientific workers in this field to what is known as food cycle. It is a common knoledge that the plant feeds the animal and the animal feeds the man, while the wastes both from man and animal feed the plant in return. Thus the relation of the sewage disposal to agriculture is clear. The simplest method of returning human waste in the form of liquid sewage to the plant is by means of sewage forming. Fundamental difficulty in the operation of the sewage form is that the crop needs only food and water at certain periods while the sewage comes down daily without ceasing.

Sewage farming is a well-known method of sewage disposal but when the soil is not suitable for sewage forming, fish ponds have been helpful both for the purification of sewage as well as for the cultnre of fish. In Germany it has been found that fish ponds are more profitable than land farming, as poor land can be made more productive in this way. The fish grown is carp. It has been found that sewage from about 800 to 1200 persons can be handled by one acre of pond producing 1600 pounds of healthy carp per annum.

Advantage :— The purification in fish pond is affected by innumerable by small organisms which serve as food for fish. The largest installation of fish pond is at Munich, where sewage from 700,000 persons is treated on about 550 acrea with 30 ponds. The average return of fish flesh is 425 pounds per acre per annum. The sewage is on the combined system and on arrival at the works, it is screened and passed through 16 two story settling tanks. She affluent from the settling tanks is discarded to equalising tanks situated on the right and left bank of river Isar and from these equalising tank it is pumped into fish pond situated at higher level. At the same time these ponds are fed with river water, the amount varying with the season.

In India there is only one instance on record of scientific breeding of the fish with sewage. A tank on the estate of the Government Riffle Factory at Ishapore near Calcutta is fed with the affluent from activated sewage plant and the fish cultured in it are stated by Eurpoean consumers to be of excellent quality.

Ordinarily crude Calcutta sewage contains 99.9% of water. The remaining constituents (usually much less O. 1% of the total product) include objecticnable substance which may be classified as follows:-

IN PARTS FOR 100,000.

Floating solids.	Suspended solids.	Albuminoid NH3.	02 Absorption.
Fats and grease.	37.7	0.71	4.9

Suspended solids. Calcutta crude sewage.
Organic matter.
Bacterial.

On the standard of Albuminold ammonia and 02 absorption sewage of Calcutta is much weaker than that of any other cities in India.

In Manchester Bermingham, Chicago and other cities, sewage is treated by activated sludge process which is recognised to be the most up-to-date and effective means of purifying sewage. In all these cases it is found that the purification is affected about 85 % on the basis of 02 absorption and 82% on the basis of albuminoid ammonia

The physiological response of fishes to different concentration of the sewage depends on the amount of dissolved 02 present in the sewage used and that the reaction takes the form of respiratory embarrassement which however subsides as soon as the medium is mechanically aerated.

As soon as the solid matter contained in the sewage settles down and purification starts, 02 tension in the water greatly reduced with the result that the fish begin to feel respiratory embarrassement and ultimately die of asphyxiation. That is the reason why in the first eight miles of the sewage channel where solids settle down at the bottom, the

conditions are found to be sceptic for fish life. Plant life is very scarce in the sewage channel to a distance of about 8 miles. Fishes provoided with accessory respiratory organs, however, (Anabas, Murrels) tolerate to a great digree the sewage through the channel.

The sewage in proper dilusion can further be put to a greater advantage as an important food for the fish as well as paddy can be grown as alternation of crops. The fish feed directly on certain suspended matter of the sewage while the diluted affluent enhances the growth of phytoplankton, and the dark sediment forms a good manure for the paddy crop. This sewage irrigation fishery is successfully being carried out in Dhapa area in Bengal.

NUTRIENT VALUE OF *SEWAGE* SLUDGE AND SEWAGE AFFLUENT.

Sewage contains chemical consitutents like nitrogen and posphorous which possesses fertilising value. Sewage sludge as fertiliser has been used and is been used in many countries like, Germany and America. Apart from its nitrogen and phosphorous contents, the humus in the sludge is known existant in cases of artificial manure like sulphate of ammonia.

Besides these, in recent years, eminent experts like Rodolf, He inemann and Ingols have established the sewage sludge contains growth producing substances something similar to Roboflavin, a growth promoting vitamin. Riboflavin is a chemical name of the compound formerly known as

vitamin G, and at present vitamin B 2 Riboflavin, is found to increase the germination pollen grains. It is also observed that this substance in proper concentration in chicken feed, increases the hatchability of eggs. This Riboflavin is considered essential to the well being of the animal life as well. The efficiency of this vitamin may cause a decrease in the rate of growth under production. This defficiency would also cause disease of the eye, the skin and nervous system.

In raw sewage, a substance similar to the above vitamin is present is concentration varying from 20 to 44 micrograinms per litter and still has practically on effect on the Riboflavin content of sewage. Affluent from activated sludge plant however contains only 4 to 5 microgramms of this substance.

The conditions under which the sewage matter may be discharged into any body of water without difference in the present connection without the likelihood of harm to the fish, will depend on several factors namely:

1. The concentration or strength of the poluting discharge.

2. Its volume in relation to the body of water with which it is mixed and thoroughness of mixing.

3. Cleanliness and the O2 contents of this body of water.

AQUATIC VEGETATION—AND FACTORS DETERMINING ITS GROWTH.

1. Temperature, 2. Density and 3. Dissolved Salts are the three main factors that determine the growth of aquatic vegetation.

On inclement weather, especially in ponds etc., the over-growth vegetation and bottom debris, is due to the absence of sufficient sunlight. The Photo synthetic activity will be low to maintain the biological balance and consequently the liberated carbondioxide will not be absorbed and the result will be the increased acidic contents of the water; thus making animal life impossible to thrive. To remedy this, resure the fish by dragging the pond with a close meshed net, remove the bottom debris and agitate the water so that more and more oxygen content of the atmosphere can come into contact with the water and the carbondioxide content lessens. Allow the water then to settle and reintroduce the fish. It should be remembered that the tropial waters bring about rapid growth of organisms as well as their sudden decay.

The temparature of water at the surface will be lowest in January (22 5° c.) and highest in May (34.5oc. to 34.7 oc. at 12 Noon). 34.5° c. Maximum temperature will be at 2 P. M. With the onset of monsoons in the 1st week of June, the temperature falls by 1° or 2° and then remains almost constant to the middle of October. Then it starts falling rapidly reaching the minimum in January.

P. H:— H denotes hydrogen iron content where P is constant. Surface water value of PH

is 7.4 to 9.0. PH value of bottom water shows slight seasonal changes. It ranges from 7.45-7.65. It is always lower than that of the surface water. The change of P H same of water seems to be connected with photo-synthetic activity of the chlorophyll bearing organisms which are dependent on the condition of weather and necessary salts available. PH symbolyses the hydrogen iron concentration that serves as an indicator of alkalinity or acidity for lemnological Purposes. The PH may vary from 3 to 10 (Usually from 6 to 8) accordinag to the contents of water and season etc.—

ACIDITY, ALKALINITY AND PH.

Organisms reach differently to conditions of neutrality, acidity and alkalinity. Distilled water is neutral and its PH is 7. Above 7, PH indicate alkalinity, mostly because photosynthesis using up carbondioxide and carbonates are produced. Limy soil may also raise the alkalinity. Spring water coming through the earth with decomposing organic matter is rich in H2COZ and hence acidic. Sewage and respiration of crowded biota are other causes of acidity.

If the pond is full of plant life, it is alkaline and so PH is greater and if the pond is over abundant with animal life, it is acidic and PH is less. The best suited PH for fish life is 6.5 to 8.5.

AQUATIC FLORA IN THE ECONOMY OF FISH LIFE.

Thermoclime is the fall and rise of temperature Thermal stratification is the different temperatures in different depths. In oligotrophic lakes the thermal stratification exists throughout the year. The thermic influence of the environment upon the living world of waters is direct and considerable. Its result is an adding to the caloric energy of the combustion involved in respiration and is consequently always of great importance. The thermal capacity also varies with the richness of the aquatic vegetation.

Aquatic vegetation can be classified as follows:— Flowering plants; and algae flora. The flowering plants which are mostly of submerged aquatic plants are of three kinds:—(1) Those which are attached to the bottom (lab lab etc); (2) Free floating (Pistia; Dutch weeds etc). (3) Partly submerged- (lotus etc).

The algae flora constitutes the following:— Benthic and rotating algae. The benthic are those attached to the soil and they are mostly filamentous in nature. These leave their attachment after some time and take to float- e.g., Chara netilla. Algae which are attached to stones and plants etc. have disc shaped structures and other devices. (Spyrogyra). The rotating algoe are the phytoplankton.

The flowering plants are directly consumed by fish. Fish like Etroplus, feed on vallis neria,

hydrilla etc. These are found out in stomach contents. The food cycle is easily found out by examining the stomach contents of the fish and then examining the animalsfound in the contents.

The conditions affecting the biological productivity are

(1). Atmospheric condition, (heat, light and rain). (2) Physical condition (turbidity and volume) (3). Chemical condition (nature of soil, organic matter, aeration, variations in salts and gasses produced.)

Fish mortality depends upon the presence of oxygen which in a way, is produced by the plant life and for the growth of the plants, nitrates, phosphates and calcium are some of the important salts and elements by which the fish is enriched.

HELPFULL BOOKS ON THE SUBJECT.

1. Limnology by welsh.
2. Structure of algae by Fritzch.
3. Various kinds of Ponds and Fresh water biology by Prof. M. Ayangar.
4. Diatoms of south India. by Venkataratnam.

FISH POND FACTORS.

THE SOIL:— Clay is the best owning to the retentive power and good for vegetation. The soil must be fertile and impervious. Clay is fertile soil, and its sterility can be improved by spreading one foot layer of rich loam. But the clay

cracks up when it dries, thus a disadvantage to the vegetation grown there. So its condition should be reduced to loamy soil. Loamy soil is nothing but clay, sand and DETRITUS (decayed vegetable soil found under trees- and it is rich in nitrogen).

THE WATER:— Reddish brown tfnt is unsuitable for fish culture. Very clear water denotes poverty of Planktonic food for fish. Light green tint of the water is the best for fish culture. If brownish, treat it with detritus. Cattle manure should be put into a pit covered from Sun and rain to Prevent Nitrogen from escaping. Dilute the manure 1:2 earth detritus and then add it to the pond. Manure should not be put into the pond.

Vegetation:— Rank over growth of vegetation is harmful. Healthy scattered vegetation is the best. Shrubs and sparsely scattered trees on the bund prevent erosion, offer shade and nestle fish exercise Natural shade is required over a pond. for fish to take shelter on a hot day.

QUICK GROWING TREES GOOD FOR SHADE.

1. Rain tree (Pithacalobium saman- Telugu:- Nidraganneru). The fruits of this tree are sweet and borm very good food for fish as well as cattle.

2. Portio tree (Thespecia populnea- Telugu- Gangaravi chettu).

3. Citrus (Orange etc). Mango trees, Cocoanut trees.

If there are no trees, artificial shade can be given by suspending bamboo trees by ropes to the poles fixed to the bunds.

VILLAGE TANKS:— See that the bottom is cleared up of the debris and fresh rain water turned into green. See if any life can survive in the water-put some fish and if they do not come to surface within 2 or 3 days, it can be presumed that the water is a safe one. Put some Vegetation for photo-synthetic process. Cut leguminous plants (Telugu:- Vempali chettu) and put them in the pond bed and let it decay. This forms cheap food. (Vempali if cut and put into the pond bottom, nuetralises the alkakalinity of the pond. Beans (chikkudu) can be cultivated in the seasonal ponds, to a great advantage).

Manuring:— Regulaled supply of farm refuse and fresh sewage forms a very good manure to the fish pond.

Coustruction of ponds is entirely artificial Conversion of ponds is converting any piece of, water for cultural operation.

Factors to be considered:— Water supply,- Natural like river, spring, irrigation channel tube wells etc. The supply should be in abundance- and Perenniel. If it is irrigational, amount payable for water used should be considered.

Spring is cheapest- but has gravitational flow, which can be checked by controlling with shulters and Sluices etc. It should be free from mineral

contents. If not free, expose the water by constructing long channels connecting the spring with the pond. If the pond is too near the spring, the canal connecting the spring and pond, to be lengthened by a winding channel.

Rivers-either over-flow or dry up and necessitate pumping the water up. Sitting is another handicap. But it is advantageous since it contains food material and rich in nitrogen compound which causes photo-synthesis of planktonic life. The silt is disadvantageous as it raises the bed of the pond and decreases the depth and volume of water. This can be remedied by erecting a side-mentation tank.

Location of site is another factor which should be considered carefully-to see that there is demand on the spot for the fish caught. If no demand transport to other markets; communication to the markets, preservation and transport in a quickest way to be considered. Set up agencies in different markets to effect quick sale. A well settled land with enough space if possible with pieces of water around and loamy soil should be selected. Shade is essential to prevent evapouration and high temperature. The pond should be more of a rectangular shape than round or square to fecilitate easy netting.

PLANTS SUITABLE FOR IMPROVING MARGINS OF LAKES.

(From journal of Bombay Natural History society. Vol. XXXVI No. 1 dated Nov. 15, 1932)

The banks and margins of lakes could be improved in a manner involving no very considerable money by the introduction of suitable vegetation–

THE CREEPING RUSH (HYGRORHIZA ARISTATA) is a particularly useful plant and has a natural habit of sending out long runners upon the surface of the water from which spring a multitude of rusk-like leaves forming an attraction and resort for ducks and waterfowl, whilest below the surface is a mass of interlaced roots providing a safe retreat for young fish until they reach finger ling size. This creeping Rush thus helps very materially to improve any sheet of fresh-water where some protection to the young fish is needed. Supplies are abundant at the Vard Tank- Bhiwind. Kalyan and no doubt in other places also. Short lengths of a foot or so pushed into the mud at the side of a lake and on the water level is all that is needed to start the growth of the Rush.

WATER LILIES (Nelumbium speciosum and Nymphoea lotus). The planting of these might be done in small patches, wherever the depth of water is suitable and thus would be provided shade from the Sun's rays for the larger species of fish. 'Gardening in the Tropics'- woodrow-refers to N. Lotus as 'This ground water lily with flowers of rosy -red in W. India'. The planting is an easy matter as the seed could be enclosed in walls of mud and wrapped up in pieces of canvas and then could be thrown into the water in quantities of half-a-dozen or so in selected spots wherever fairely deep water occurs a few yards from the banks.

PAMPAS GRASS (GYNERIUM ARGENTEUM)

Grows to a height of 10 feet and is a beautiful ornament for the higher parts of the banks of lakes. It is a perennial, and very easily, established and would provide shelter for small game such as birds and hares etc. Intermixed with it might be planted some of the common cactus which would greatly improve this *Small Game Retreat.* Seed of the Pampas Grass is obtainable from Messrs. Ryder and son, St. Albans, England or clumps of old roots can be divided into small pieces and planted in holes specially prepared. The cactus can be cut into lengths of a few inches and dibbed into small holes, and will be quickly established and in combination with the Pampas Grass will make most useful and Ornamental cover for the encouragement of small game.

SEDGES (CYPERUS CORYMBOSUS)

Sedges of the taller kinds, 5 to 6 feet in height, provide shelter for ducks and small birds and are, as well, an ornamental addition to the margins of lakes inclined to a damp and muddy condition. No difficulty would be experienced in making plantings as pieces of root can be established. The plant is common wherever swampy ground occurs.

WILD RICE. (ZIZANIA AQUATICA)

would involve no very expensive work in making plantings. The seed is procurable from Messrs. Ryder & son., St. Albans, England, at 20 shillings per pound. It is well known as a great attraction to ducks and other water fowls. It is a

perennial, and grows to a height of 5 feet. An easy method of making plantings is to place each seed in a small ball of mud, the size of a marble, and when dry and firm, scatter freely in places constantly wet and muddy, if treated in this manner, the work can be managed expeditiously and economically"

DEWATERING AND DESILTING.

In artificial tanks we would have already taken precautions providing sluice arrangements for inlets and outlets Filling up a tank or emptying it, is a process which can easily and cheaply be controlled in an artificial tank. This is not the case with natural ponds of immence dimensions which cannot be controlled economically. It is not difficult to deal with ponds of smaller sizes. When the water becomes foul due to decaying vegetation or accumulation of bottom ooze or some poisonous element having gained access, the tanks have to be emptied pumping with the aid of machinery may be economically prohibitive and hence the need of resorting to cheap methods.

The bottom has to be well stirred by men or cattle so that the ooze may be dissolved into the water and the water baled out by means of pecotas or baskets. The cheapest and the best machinery for pumping out water is Archemedes Screw which can be hired from the nearest agricultural demonstrator. When desilting is over, it is always advisable to allow the bed to dry for some time (A month or two).

CONTROLLING SILT AND INFLUX OF PREDACEOUS FISH, UNDESIRABLE LARVAE OR EGGS EROM POND.

Sedimentation or Silting Tank. In artificial fish ponds, we can control the above by means of constructing additional ponds. Midway between the fish ponds and the source of supply of the water, a filter bed has to be erected diagnally so that it can avoid hydraulic pressure and also get the maximum surface area for filterisation The filter bed should be filled- with jelly and the internal layers with pebbles, gravel and coarse sand well washed before hand. This will filter away all undesirable things. The filter-bed should not be too thick, nor fine sand used so that filtering process may not be unduly delayed. It is always safe to have sedimentation tank, equal to the size of atleast one pond. In natural ponds periodical netting and removal of Predaceous fish is only the best course possible.

EASY METHOD OF CLEANING AQUARIA OR PONDS. *By H. K. Mookerjee, D.Sc.*

Head of the Department of Zoology, Calcutta University From The Indian Farming Vol III No. 12. 1942)

" In maintaining fishes in aquaria, considerable difficulty arises in keeping the water clean since it becomes contaminated with accumulation of the excreta of fishes and waste food particles. Cleaning may be done by dewatering the tank and adding

fresh water, but this is troublesome on account of the presence of gravel or pebbles at the bottom and there is a chance of injuring the delicate fishes in scrubbing the floor of the tank covered with vegetation. It would be easiest if the refuse could be frequently removed by means of siphon which can be easily made anywhere at a low cost and has advantages over other types.

SPECIFICATION OF THE SIPHON.

For small aquaria a small siphon is recommended. The lower part of the siphon is made of a tube one inch in length and ¼ inch in diameter. It is the basal tube since it is attached to a double jacketted tube. The outer jacket is about 3½ inches in length and 1 inch in diameter. The inner tube should be a little less than ¼ inch in diameter and about 3 inches long and free at the upper end. The free end of the inner tube should have an opening at the side and not on the top. The cost (prewar) of making a siphon at Calcutta was 6 annas if made of tin, and is a little more if any other metal is used.

DIRECTIONS FOR USE. close the upper end of the long tube of the siphon with a finger and dip the siphon vertically in the water. Now remove the finger from the tube and give a sudden jerk to the water inside the siphon. The refuse and sediment at the bottom of the aquarium together with a quantity of water, will be drawn up along the basal tube and will pass through the inner tube to the outer tube or the space within the Jacket. The siphon should now be taken out of the water.

The refuse is poured out along with the water by inverting the siphon. The process is repeated.. The bottom surface of the aquarium can thus be cleaned by siphoning.

LARGE SIPHONS FOR PONDS.

For cleaning ponds, large siphon is required. It should be 10 to 12 feet long. The dimension of the other parts should be proportional to the relative length of the siphon, which is made on the same plan as the small siphon described above. For covenience of scraping the bottom of the pond, a few steel nails may be fixed as the end of the basal tube of the siphon. The parts of the siphon are made from the galvanized iron. The cost of making this (prewar) was Rs. 3/- in Calcutta. As it is impossible to close the top end of the large tube by means of a finger or thumb, a cup or lid may be applied for closing this end of the siphon before it is immersed in water. To work the siphon the cap should be removed as soon as the lower end of the siphon touches the bottom of the pond.

From a big pond, one can take out by this siphon in 24 hours, easily 19 buckets of rotten matter, jet black in colour. It is advisable to use either a boat or a float for siphoning a tank. The waste liquid from the bottom of the pond can be used as a fertiliser for plants.

CLEANING THE POND.

At the bottom of the pond, one generally pnds a thick layer composed of algae, weeds, protozoa, crustacea and other organisms which are suitable

as food for fishes. Besides, at the bottom of the pond, there are accumulations of effete matter from the fishes, rotten vegetable debris, decayed animal products, and washings from the surroundings brought in with the flow of rain water.

The decomposition of this sediment or organic matter ultimately leads to the production of Carbonic acid gas, or in extreme cases, marsh gas causing asphyxiation of the fish population. Such decomposition at the bottom of the pond may be checked if one periodically uses the siphon and removes the rotten matter from the bottom of the pond. It should be borne in mind that the siphon must not be used too frequently for the simple reason that if all the debris at the bottom of the tank be removed, the natural food of the fishes would pass away along with it and this will do more harm than good.

Siphoning the rotten matter from the bottom of the pond will prevent formation of toxic, gases lowering the PH. of the water and consequently regarding the growth of bacteria and infections deceases. In addition, it is advisable to have the water of the pond aerated by means of the inner tube of a motor tire (See - A chief method of oxygenation in fish culture by H. K. Mookerjee - Indian Journal of Veterinary Science and Animal Husbandry- Vol X- No. pp. 289-90), since oxygen kills most of the bacteria of the water, preventing thereby the lowering of PH.

It may be mentioned here that the process of siphoning given above is not only different from the siphon recommended by Milner (J. W. Milner– Report of commissioner of Fish and Fisheries, United States, Part II Ch. XIX, 444–5.) but is more advantageous for use in Ponds as well as in aquaria. Milners' apparatus consists of a piece of rubber hose, to be used as a siphon for removing dead fishes and other settlings at the bottom of the aquaria. The rubber hose is attached to the end of a piece of a lath, one end of the hose is put into the water by keeping the lath at the bottom of the aquarium and the other end is placed outside the aquarium. When it is filled with water and lowered, the water will run out freely and thus the dead fish and settlings at the bottom of the aquarium will be carried away along with the flow of the water.

Although simple, this instrument has this draw back that it can only be used if the aquarium or tank is placed on a higher level than the surrounding. But ff the aquarium is placed on a lower level this mode of siphoning fails.

The Siphon described here can be most successfully used both in ponds and in aquaria."

CHAPTER V.

FRY COLLECTION.

There are few districts in South India so lacking in useful cultivable varieties of fish that sufficient numbers of indegenous Labio, Cirrhina, Catla, Etroplus, Chanos, Muzil or some of the larger varieties of cat fish or the exotic Gourami, Tench and English Carp etc., cannot be secured for stocking ponds. The fisheries Department help the fish breeders with advice and supply now indegenous variety such as Gourami, Carp, Tench and Etroplus, Catla etc., which are not available in most districts of the presidency. A little enquiry and personal efforts in fish catching and transport on the part of the prospective culturist will help to increase his interest and knowledge and to find suitable fish fry for cultural operations at little or no cost. Ordinary fishing tackle such as a cast net and hook and line in the case of fish that take a bait are sufficient for catching fish from the neighbouring lake or river for stocking purposes. The fish will not be injured by the hook if they are unhooked and discharged carefully after being caught. If a fisherman with a net could be hired, so much the better. Care must be exercised in selecting the fish so that predaceous varieties are not unwillingly introduced. The majority of the fish enumerated above with the exception of Gourami and Etroplus, will not breed in the stationary waters of the ordinary ponds. It is therefore necessary to resort to the method of collecting the spawn, fry or fingerlings of these species from the adjoining lake or river where they

breed. The local fishermen have the necessary knowledge regarding the breeding and fry collecting grounds. If a local fisherman's service can be secured, the fry or fingerlings are easily secured. The fishermen, however are surprisingly ignorant of scientific methods and the pond keeper must therefore personally attend to the selection of the right kind of fish until the fisherman knows to distinguish the fish even in the early stages. The pond owner should insist only on the securing of the right kinds of fish which are enumerated above. Young murrels, wallago and Gobius should be carefully avoided. The following particulars about the collection of fry and fingerling will be found very interesting to a pisciculturist.

HAP NETS FOR FRY COLLECTION.

As the eggs will be floating just below the surface of the water, this contrivance is half submerged in water by tying the ends of the floating net to bamboo stakes driven into the earth. The spawn and the larvae that pass through the mouth of the net will be blocked at the end where a bag like net is attached and are removed carefully and transferred into the receptacles seperating the spawn and the fry by means of a seive. At the close of the day the fry are transferred into the nursery pond and the spawn into the brood pond. There is no need of giving the fry any food.

METHOD OF FRY COLLECTION IN RIVERS

The collection of eggs and fry at the upper reaches of the rivers where fish breed is very difficult since almost all the rivers are very rapid in Madras province. Hence the fry is collected in paddy fields where only 50% of the fry are useful for the culture rest being the fry of the unwanted and predaceous fish.

To collect eggs or fry at the spawning places in the rivers higher up, a place which is shallow and protected from the rushing water is selected for fixing up the net. Usually a small island in the river is selected and the net is placed at the farther end of the island so that it is not exposed to strong currents and the fry is cought in the cloth bag attached to it.

The recepticles in which the fry and the spawn are kept is made of cloth like a floating trough and kept in the water ¾ of it immersed, keeping it in position by fixing the bamboos. The trough is made of cloth, so that the eggs and larvae and fingerlings do not get injured by coming into contact with hard surface. Collection of fry and fingerlings is done in the paddy fields by means of close meshed basket traps called 'Mavulu'.

NOTE ON FRY COLLECTION OF CATLA IN MADRAS PRESIDENCY.

As the best and fast growing carp suited for pond culture, catla is extremely stocked by the Madras Fisheries Department in the numerous provincial waters for increasing the supply of fish

to the public. With the growing popularity of fish farming there is an increasing demand for stock of fingerlings. To help a fuller exploitation of the sources of Catla fingerlings, the essential details to be observed for successful stocking are given in this note:—

In the tea-coloured rapid moving flood waters of the Kristna and the Godavari rivers, Catla spawns during the South-west monsoon (July to October); the physical and chemical nature of the waters and the change of weather offering the optimum conditions. It is reported by the local fishermen that its eggs are pelagic and appear in whitish frothy masses and drift with the current from the upper shallow reaches of the rivers where the beds are stony or gravelly. (This statement requires confirmation). These egg masses drift down along the margins of the rivers when the current is less turbulent. They hatch either in the rivers in their journey or after entering the irrigation canals which take off from the bank of the rivers. They pass through waters of decreasing depths till they ultimately get distributed into the apparently inundated paddy fields and the adjoining irrigatiou tanks. Fingerlings of Catla which enter these tanks grow to adult and marketable size by next summer (February to June) according as the tank is perennial or seasonal. Fingerlings that find their way into such tanks are only a microscopic minority of the year's progeny but the millions of the majority get into the fatal paddy flats to meet with immature death being trapped by men in ingenuously woven basket traps, locally known

as "Mavulu" or destroyed by the natural enemies like birds Crabs and snakes. They die in their millions on account of also the fall of water level or the drying up of paddy flats. The "Mavu" is essentially a box of basket work admitting free passage of water but entrapping fish which may enter through two inlets, one on the down stream side and another towards the upstream. The "Mavu" is placed across the bed of the stream; any side flows being prevented by constructing temporary bunds with sand, clay or twigs. These basket traps are also set up across the Sub-Channels and drops from higher to lower paddy flats. Fry fingerlings moving up and down the current are entrapped in these fixed engines which thus form a permanent feature of fishing throughout the irrigation season. These immature fish are either sold or consumed by those that trap them. The majority of the catches are carps, mostly catla. Catfishes, Crabs and Prawns are also trapped in small quantities. These collectors who are none but the innocent agents of destruction are singu-largly men with misplaced sympathies. While destroying potential fishery in its infancy, they give liberty to the enemies of fish-Viz; crabs to burrow and damage the bunds of the fields. When trapped in the baskets, the crabs either feed upon or impaire the carp fingerlings irrecoverably. The collectors of live fish fingerlings for stocking purposes, go to the spots where the traps are fixed and select and collect the required fingerlings and transport them to the common conditioning pond in case of long distance travel or directly to the pond intended for stocking either in tins or brass vessels or earthern pots. In

the case of distant transfort, it is well known that fish have to be "conditioned" in specially designed conditioning boxes. The period of this starvation and acclimatisation to the limited space, varies with the size and health of the fish, the bigger and healthier fish requiring a longer treatment extending to three days (average being 2 days). Fingerlings of 3 inches in size are best for transport. Experiments in transporting fry below 1½" practically without conditioning, have been successful. The following precautions have to be taken in conditioning and transport catla and other fresh water fishes.

APPROVED METHODS OF TRANSPORT.

After the fish fry has been collected, the correct methods of transport must be employed. It is a well-known principle among the pisculturists, that fish immediately after capture are unfit to travel except for a few yards. They are not only unaccustomed to ristrict the space and are apt to dash and injure themselves. They often have undigested food in their stomachs which they are prove to vomit during the transport and foul the water of the carrier.

CONDITIONING

An essential preliminary to transfort therefore, is the process called "conditioning", which can be effected in special boxes with perforated sides or ,live cars' which are berrels or boards with

perforted bottom and sides or better still in temporary enclosures erected with nets or bamboo tatties.

A net enclosure is therefore, the best method of conditioning such fish, as some breeders object to the use of conditioning boxes. It is desirable to condition the fish before transport, i. e., imprison and starve the fish in any of the above contrivances in the tank, river or lake from which they have been captured.

Sudden change of temparature or other physical or chemical properties cause heavy casualities among the fish. This is altogether avoided if the fish are conditioned in the waters from which they are taken. The larger the fish are, the longer the period requiring for conditioning. Even the most spirited fish can be rendered sufficiently docile by careful conditioning. The transport of fry and fingerlings is much easier than that of the adult fish and except when absolutely necessary, it is advisable to transport only fry and fingerlings.

PRECAUIIONS TO BE TAKEN FOR CONDITIONING

1. Wire mesh conditioning boxes especially those pointed may best be avoided since the finger lings-often brouse on the sides and suffer badly. Close meshed basket-trap like boxes are the best cheapest and profitable. The bigger the mesh guage, the more will be the chances of injury to the mouths of the fingerlings.

2. Ponds of muddy bottom should be avoided, since the wading through by the attendant disturb the pond bottom and impart suspended

impurities to the whole volume of water, rendering it very unwholesum for the fish and clogs and chokes the gills causing fatality. If this cannot be avoided, a wooden submerged platform may be provided for.

3. Shade is essential. In the absence of natural shade, a pandal is necessary.

4. Never handle the fingerlings with hands or cause friction on their bodies, lest the slime and scales may be removed, making the fish more vulnerable to fungus attacks. Soft hand nets are handy.

5. For transport, use clear, cool, natural and decanted water. Brackish water even nearing fresh water in taste is harmful to the fingerlings.

6. Transport or preparation for it is best avoided from fore-noon to after-noon (10 a. m. to 3 p. m.). Temperature above 30°C or 80°F and below 20°C is dangerous. The optinum range is 26°C to 30°C.

7. Change water at least at an interval of 4 hourse. Chlorinated drinking water is not recommended.

8. Water taken from other sources including Railway hose Pipes etc., should be allowed to cool and settle down at least an hour before use.

9. Removal or replinisining can be easily done and quickly done by gently tilting the tin carrier to run the water off and pouring in water

from a hight through the perforated lid in place. Never let go strong currents directly into the tin.

10. Woollen covers being non-conductors of heat and promotes coolness, are recommended to be used, by covering the whole tin carrier after wetting the woolen cover.

11. In railway, the tin carriers are best transported in the break van nearest the engine, to avoid much of the jolting.

12. For abso'ute safety of the fish, 50 to 60 fingerlings in each tin carrier is the maximum, thou h an experiment of 130 to 200 fry below 2" has been successful.

13. Conditions existing in the water body to be stocked have to coincide with those in the tin, if not they must be made to agree by artificial means. For that slowly change the water in the carrier with that in the tank. Allow some time for the fish after equalising the conditions to recolcile themselves to the altered condition. Slowly dip the carrier in the tank and remove the lid to allow the fish to work their way into the open waters. Stocking should be preferably done in the early hours of the day, when the temperature of the open water is rather low.

14, After a long period of starvation, and travel, the fingerlings naturally be weak to find their proper sheltered parts in the new waters. These will be just lurking in along the margin in search of food and shelter. This is an opportunity for poa-

chers and birds of pray. The fishing attendant will do well to guard the immigrants against the above enemies for at least a few hours (i. e., till they gather sufficient strength to defend themselves.)

MARKETING, STORAGE AND TRANS-PORATION OF FISH.

" The present system of the fishing industry in this province is primitive from the catch to the sale. Except for a few beels, jheels and certain portions of river which are quite close to the cities and towns and from which the fish is supplied in a fresh condition, the overwhelming majority of chief fishing centres are far away from, the nearest rail or steemer heads. And the transport from the actual places of fishing to these main centres of communications which in certain cases are 60 to 80 miles distant, is being done by country craft capable of only very slow progress and usually travel with tide. To mention a few instances the fishes (Hilsa and Bhekti), caught in the vicinity of the mouth of Passur river is invariably brought to Khulna etc., rail heads; by only country boats mostly. From Nalianalla to Hasanbad and Basirghat it takes two and three tides respectively for the transportion and from Sunderkota or from the vicinity of Katka Char it takes 16 tides to go to Hasanbad by country boats.

Motor launches have come to be used for fish transport in recent years in the winter season from October to February. Usually second hand motor car engines are installed with adjustments for marine propulsion. The launches are used for

passenger traffic during off season. Even from distant places which takes three to four days for transporation, the fish are brought by launches. The consignment is despatched from even places which are of 3 to 4 days for transport. It is despatched from Bhola at 9 P. M. by passenger boats of 200 maunds capacity – arriving Barisal by 6 A. M. next day. No. ice is taken in this trip as the transport is in the night. At Barisal the fish is packed in 4 maunds capacity box with 1 cwt., of ice. The box is re-iced at 5 P. M. just before the steamer express leaves, with ½cwt. of ice. It arrives at Khulna by 5 next morning and immediately leaves by train to Calcutta arriving here by 10-10 A. M. The box is again iced on arrival with 1 maund of ice at Sealdah and kept there till next morning when it is sold usually between 5 and 6 A. M. Thus it takes practically four days for the whole journey.

The following is another typical instance of how fish is disposed of from its catch to sale indicating the various stages and charges en-route. One head man of a batch who was fishing near the Sunderkota Khal on 23rd May 38 reported that he had taken a loan of Rs. 250/- from a Mahajan of his village at one anna per Rule per month interest. It takes for his 16 tides to go to Hasanbad from Sunderkota Khal. His aratdars are at Calucutta. He pays annas 4 as cooly charges at Hasanbad and annas 12 for a hand cart fare at Calcutta. A hire of annas 8 for a box is also paid by him. In eachl box he puts 2½ maunds to 3 maunds of ice and 3 to 4 maunds of fish. Cost of ice is Rs. 1-4-0 per maund and Railway freight to Calcutta is Rs. 3/- per

bax. He leaves Hasanbed at 4 P. M. and reaches Calcutta by 9 P. M. The same night or the next morning he takes the consignment to aratdar's house and thence to the market where the fish is sold by lots or by maundage at 5 to 6 A. M. His aratdar takes 12 per cent., of the gross proceeds and the balance paid eventually sometimes after two or three such trips. He represented that they were fishing in Sunderbands from 6th February and March. They had realised Rs. 65/- plus Rs. 95/- total Rs. 160/- for three trips. The proceeds are divided among themselves according to the share system as follows:-

Half a share for Dhinghi, one share for net and one share for each man.

It is desirable that properly sloping selling platform and flooring with suitable drains should be provided in all markets.

From the point of view of transport fish fall under three groups:-

1. Those that are transported in the live condition,
2. Those transported without any preservative such as ice.
3. Those packed with ice (ordinary wet ice - or dry ice.

Those carried in the live condition are the murrels etc., These by reason of their possession of certain accessory pulmonary apparatus are able to live for a long time without water provided the Gill

chambers are kept moist. So these are generally carried in pots with a litle quantity of water or in baskets with a few wet green water weeds or leaves and a piece of wide meshed net serving as the coves. Even in markets these are kept alive in shallow earthen troughs with water.

Certain carps, Catla etc., are carried across long distances in what are known as live-wells, cover with perforation in the hold to admit of free flowo f water.

Certain esturine fishes and prawns eg., Bhekti Chingdi are often kept for days during fishing and then carried to the chief rail or steamer heads in a sort of cylindrical split bamboo frame work with a trap door at the top for putting the fish in or for, removing. These are known as Hapers. These have inverted pots or raw plaintain tree stems attached on either side towards the top to keep the haper afloat at the surface with just a small portion of it alone exposed outside. It is needless to say that for a primitive country boat to take under tow such a large live car the haper, its progress is considerably retarded and during this long and tedious journey though the fishhermen attempt to feed the ffsh, Betki in particular, with smaller fish, yet by the time they arrive at their destinaton for being packed with ice in boxes or baskets, they are lean and through days of at least partial starvation, practically dead.

In some cases certain fishes Bhekti, Kawn-agur, Aor, Sillund, Pangas etc., are tied to holes made in their lips or tied near the neck or tail and kept

dangling in the water - a much more cruel practice. Some times fish is kept in a net outside the boat nuder water.

Both ordinary and dry ice have the same disadvantage of being a slow cooling process in which the fish become soft, spongy and insipid The reason for this defect is that in the slow cooling process the nutritive fluid from the muscle accumulates in the loose connective tissue in between and form Crystals", thus breaking the muscle fundles, which when the fish thaws, melt and with it all the nutitive fluid is lost from the fish making the fish insipid and tasteless. This is why the fish presserved in wet or dry ice is spongy and tasteless and for this reason many go in for live fish and avoid preserved ones. This is perhaps one of the reasons why sea fish which has come from distant places and which have therefore to be preserved in ice, has not become more popular yet Prawns from estuarine fare worst in ice preservative. Tainted prawns exhibited for sale is quite common sight at all the markets'' (From the repot. on Bengal Fisheries).

HINTS ON MARKETTING.

The best is to keep the fish alive till they are sold. For this purpose air breathers like Gourami, murrel etc., are good. Next comes cat. fishes for hardiness and to transport. The third comes carps.

To have an assured supply, fish must be removed from the big tank and put in a small pit or a cement tank of small dimensions constructed in the market to exhibit the fish, so that at a moments notice they can be taken out and marketted.

PRESERVATION.

Teset for good fish.

Characteristics of good fish.	*Of Stale fish.*
1. Skin and colour bright.	Skin dull, spotted, slimy, colour pale or bleached.
2. Scales adhere strongly.	Scales loose.
3. Eyes clear and not sunken or wrinkled.	Eyes cloudy, wrinkled and sunken.
4. Gills red.	Gills yellowish brown or grey..
5. Flesh firm and elastic.	Flesh flabby and soft. Finger impressions remain.
6. Smell fresh, exterior and gills.	Smell stale or sour esp. at gills.
7. Little slime on skin.	Skin very slimy.
8. Boby regid or stiff.	Body flabby and limpy.
9. Body sinks in water.	Body floats in water.

Fish must be handled carefully from the beginning of the catch till they are marketted.

2. Cleanliness essential.

3. Honest treatment.

4. If caught alive try to preserve them by putting them in live cars. In case of inland fisheries small pits are dug near the fishing centres and kept there alive till they are transferred and marketted. If dead, gutting and cleaning should be

done immediately. The catches should be taken to the market in a refregirator and then to the curing yards with all speed. If viscera is not removed purification takes place quicker; (2) moisture helps putrification (3) Fish must be exposed to air; (4) hang the fish tail upwards.

METHODS OF PRESERVATION.

The fist method of preventing putrification is obviously that of preventing death (keeping the fish alive) The 2nd is that of refregeration. The 3rd is simple desection or drying with or without salt; 4th is using antisceptic preservatives like salt, smoke, venegar and boric acid and the 5th is sterilisation followed by exclusion of air to prevent further access of bacteria e. g. canning and dehydration.

CHAPTER VI.

FISHING CRAFT AND TACKLE.

There is a crying need for improvement in the Fresh water fishing craft and tackle. Much improvement has not been done in this respect due to the (a) conservation of the old fashioned ideas (b) the inland waters are mostly located in remote regions where the influence of civilization and education is generally lacking. The improvement should be effected by (1) Departmental demonstra - tins to convince the fishermen of the advantages of the improved nets, preferably of the inland fishermen themselves (2) rather than introducing an entirely a new system of fishing, it would be better to bring in more gradual modification of the existing gear and when effective utility of these innovations, fishing craft and takle should be supplied to them at moderate prices, so that even the poorest among them could buy.

NETS FOR FRESH WATER FISHERMEN.

Nets are basically divided into (1) bag shaped nets; 2 Wall shaped nets.

The most elementary type of net in vogue now and which would continue to be of great use to the inland fishermen is the" "Cast Net" which is in the shape of an inverted funnel and which is thrown down over the fish from above the surface. The base of the cone is provided with weights to make it sink down quickly into the depths. Certain types of cast nets are provided with threads attached to their perpherry and running up to the point of the cone,

so that when these strings are uniformly pulled the outer rims get folded into a circular bag which effectually traps the fish and prevent their escape. Such nets however, cannot be used in waters with a rough rocky bottom as the strings would not function. In such waters it is advisable to use a cast net which has no strings so that the fishermen could dive down to the botton and effectively collect in their hands, the fish trapped within the meshes one by one.

BAG NETS.

Numerous typs of bag nets, some are roughly hemispheres which are either lifted up after being sunk in the water; inverted from the top and ragged down below or pulled across under the water, in a horizontal direction. Many bad nets are provided with wings on either sides to feciliate their being dragged horizontally or semi-vertically in the above manner.

WALL NETS

They are iuvariably provided with floats along the tops of the wall and in most cases sinks along the bottom, are attached to keep them stretched in the water. One of the most effective of these is the Rangoon net used in the Godavari and Kistna during the Hilsa season. This net is constructed of very fine thread, tanned deep brown colour and when the Hilsas are migrating against the current during the floods, the fishermen stretch the net in a horizontal wall in the upper reaches and allow it to drift down the current, hebind which they follow in their boats. It is particularly

note worthy that there are no weights along the bottom margin of this wall of the net and only the weight of the meshes itself keeps it stretched. The loose texture of these meshes is the most important mechanical factor as a fish that turns round to escape on meeting the wall is immediately enfolded among its folds where their loose meshes effectively get twisted round its snout tail or fin.

When wall nets are anchored securely to the bottom of the fishing grounds, such as in the case of with what are termed as the deep water drift nets, which is one of the most effective gear of the deep seas. It should prove equally effective in deep reservoirs - in land. The famous cank nets of the West Coast are of this type and it is noteworthy that the fishermen prefer cotton to hemp inspite of the greater tensil strength of the later. Cotton stands wear and tear in the sea water better than hemp.

Other examples are the Herring nets and the trawler nets. In the later case there are two walls. The outer one which meets the fine mesh which get pushed into lower meshes of the adjecent wall in the shape of small pockets by the struggling fish. As already mentioned certain bag nets are provided with wings on the transition between the bag nets and wall nets is to a certain extent gradual.

CHINESE NETS.

This very interesting cotrivance is popular along the back waters of Cochin. It is a loose

square bag erected upon a frame work of Bamboos and logs and spread on a lever with a counterpoise weight, which is left lower down into the bottom near the margin of the water, where stray types percidae and oparidae are known to feed. The very simple expedient of suddenly lifting up this bag, traps the fish. Although known as Chinese nets, the nomneclature which continue to be used for the different parts of this gear, conclusively prove that this is of Portugese origin.

FRY CATCHING NETS:-

In Bengal and Orissa where there is a vigorous trade for the fry and the Spawn of economic carps, funnel shaped cast nets are erected up horizontally to strain flood waters so that all the fish life are diverted into the thin end of the funnel and collected into a small shaped compartment. A very similar type of net but constructed with materially known as botling silk, is dragged along from boats for collecting what is known as the Plankton, for analysis at the research stations.

TYPE OF WATER IN WHICH NETS ARE EMPLOYED.

(a) Shallow tanks:- Cast nets; narrow bag shaped drag nets; are the best for these.

(b) Deep Tanks including reservoirs:- Types of wall nets which are wide enough to extend into the depths would serve best when the movement of shoals are thoroughly understood, as in the case of over the deep sea till then

however, drag nets and caste nets would be effective along the shallower margin. The major portion of the fish would be located at the end of the reservoir where water supply gets in and even cast nets would be thoroughly effective here.

(c) Narrow streams.- Wall nets which cover the entire width of the stream would serve best but in the deeper pools small cast nets are more effective.

(d) Wide rivers:- The operations will entirely depend upon the volume of water flowing through these. All the types of nets should serve for fishing. But special mention is necessary regarding Rangoon Nets as extremely effective during the floods. The Rangon nets have proved their utility even in large reservoirs where the flow is negligible.

TRAPS USED IN FRESH WATERS.

Basket and Box shaped traps made of bamboo splinters or wood or even metal have been used from time immemorial for trapping fish. Perch traps made of metal wires have been tried in Indian waters but were never effective in fresh water. Where murrels abound along the narrow margins of tanks, what are known as Murrel nooses, made out of palmyrah fibre are effective and economical to remove the predatory fish.

NET MATERIAL.

Cotton and Hemp:- These are universally used all over the world and opinion is divided as to their utility. Cotton which is cheaper if thorou-

ghly back-tanned periodically and properly dried in shade should prove better in the long run. The fibre from Calatropis plant has proved to be extremely strong but the spinning of fine lines out of this material is at present handicaping its utility for fishing nets.

These nets should however, should be thoroughly proofed with Cusoy to prevent their wearing qualities.

TYPES OF FLOATS AND WEIGHTS.

Cork is the best for floats but comparatively costly, hence light wood or roots of certain trees which have proved their wearing qualities are to be used. In Rangoon nets, plantain shaped wooden floats preserved with black colour are used.

As weights, iron beeds are effective due to their better wearing qualities.

FISHING CRAFTS.

Starting from raft made out of bamboos and timber, man has progressed to 'Catamarams', boats made out of palm stem coracles - consisting of baskets covered with hides, canoes dug out of logs of wood and boat made out of planks and beams. Much has to be done to improve the above models of craft.

The portability is the most important factor for fish craft to be used in inland waters-especially as boats will have to be carried over long distances overland.

FISHING TACKLES FOR ANGLING.

1. Bamboo or palm stem and other country rods:- These are mostly useful for commercial fishing and are fitted with strong lines to withstand the pull of every fish.

2. English rods:- (a) Tank angling:- The ringall bamboo has proved the strongest yet the lightest of all material for float fishing and is extremely popular in Bengal

(b) Fly fishing.- The wood known as green heart has been most popular from ancient days. But recently rods made out of split bamboo are much lighter and strong. The hard wood selected from areca palms is excellant for its whippy qualities and can be successfully used as fishing rod.

BAIT CASTING RODS.

Tubular steel is extremely popular in America for small fishing rods of 5 to 6 ft., used in throwing a natural or artificial fly or the float fishing line.

FISHING LINES.

The fibre from the palms of India, is extremely popular owing to its resistence and strength for country hand lines and fishing rods. Their disadvantage is mainly in numerous knots by which short lengths are joined together which will produce tangles in the hands of inexperienced fisherman.

All other fishing lines are 2 types. (1) Braided and (2) Twisted.

Braiding differs from twisting. In that the several plies involved are actually woven into each other and form an outer layer for a strong inner case on the same lines as in around shoe lace.

MATERIAL FOR FISHING LINES.

Cotton, hemp, silk and calotropis serve equally for fishing lines. Experiments are being made to get an evenly twisted line of uniform thickness made of calatropis.

Brass and steel hooks are used for mounting hooks for fishing those types which have strong teeth in their external jaws.

Cotton has been popular as handlines which are generally well tanned with barks. Similar but sturdier lines are equipped with fish hooks at intervals all through the length and after baiting properly, left over night in deep fishing water.

PRESERVATIONS. There are several barks of trees which yield tanning for tanning fishing lines and nets. Bees wax has been popular for dry fly fishing of trout over the surface of shallow waters, the fishing line is floated with a preparation of bees-wax so as not to frighten the fish. In commercial fishing in the western waters, fish ing nets and long lines are exposed to the vapours from boiling tar and thus being uniformly tarred, which is found to add to their wearing qualities.

Some of the costly fishing lines are water proofed by a coating of anamel during the process of manufacture. Such lines while they continue to be light and strong are less prone to develop kinds when being fished with. As already mentioned copper sulphate is the best preservative for silk. It could be applied diluted with patrol or kerosine oil. The material is dipped into this mixture and allowed to dry. The fruit of the Diosphyrco embryoptenis yields a transperant brownish mussilage which has been used from time immemorial for tanning fish lines.

(by an officer of the Fisheries Dept., Madras-)

The bark of Cassia oriculata (Chinna Than - gedu) is used for tanning nets. Beat the bark, crush it, and prepare decoction of it and soak the net in it for a day or two. Acasia India (Nalla Thumma) bark is also used for tanning. Soak the nets in the decoction of the bark. The best colour for the net is green to commoflouge while catching the fish. Next best is brown. (Thuniki Kaya in Telugu) (in Tamil Panachikaya) is also used for tanning.

PRESERVATION OF PISHING STRINGS AND NETS.

Industry. Jan. 46. PP 255.

The following recipe for the preservation of fishing strings and nets is also applicable to ropes etc., in contact with water.

For 40 Lbs. of strings, hemp, cord, cotton nets, 3 lbs., of cutch, 1 lb of blue vitriol, ½ lb. of potassium chromate and 2½ lbs. of wood tar are required. The cutch is boiled with 150 parts of water until dissolved and then the blue vitriol is added. Next the article is entered and the tar added. The whole should be stirred well and the cordage must boil 5 to 8 minutes. Now take out the article, lay it in another vessel, cover up well, and leave alone for 12 hours. After that it is dried well, spread out in a clean place, and coated with linseed oil. Not before 6 hours have lapsed should it be folded together and put into the water. The treatment with linseed oil may be omitted.

NETS USED BY THE FISHERIES DEPARTMENT AT METTUR RESERVOIR.

SHORE NET.

This net is made of cotton thread fairly stout, Circumference of the open end is 44ft., Mesh is 1 square, Height is 12 feet. Circumference fringed with lead. A ring is attached towards the closed end through which the hanging rope runs freely. This rope divides into a numbur of other ropes of smaller thickness. These ropes are attached to the border of the opening, like ribs of an umberella. Each of these subsidiary ropes bifurcates into two before it is fixed up to the margin of the opening. While casting, the hauling rope strips out through the ring and the net spreads out in the water and

settles down quickly because of the weights. The net is pulled up when the hauling rope is dragged up. When the hauling rope is pulled out all the lead weight gathers towards the centre and the ends are turned upwards, thus closing the rough mouth of the net imprisoning all the fish within. This is effective in shallow waters. It could also be made use of in deep waters. The net is tried and found useless in the reservoir during the deep water fishing experiments.

FRY NET or Aranjan valai.

When the draw cord or the hauling rope is pulled up all the lead weights draw towards the centre and upwards and then closing the net tow - ards the centre and upwards and the closing of the opening of the net. This is similar to shore net in every detail excepting the thread of which it is made is extremely fine. Mesh is ½" square. It is a delicate net. The circumference of the open end is 49 ft., 19 inches. This is solely used to catch fry and fingerlings. Radius 11 ft., central thread 18 ft.

BASKET TRAPS

Made of Bamboos and used to catch fish in small canals. Very useful to collect fingerlings.

PERCH TRAPS

Chiefly used for capturing eels cat fish, etc., which damage the ordinary nets. Crabs or small fish are used as bait.

Made of bamboo splinters or iron bars. These traps should be Placed at the bottom of the waters or suspended at mid column.

MURREL NOOSE

This is made of reeds and usually kept at Crevices of rocks etc., where murrel haunts and lays eggs. Hundreds of these are put. The fish goes into it and when it catches the bait, it cannot turn back since the noose is very narrow and if it recedes back, the fish is caught by its fins and gills.

SARATU VALAI

Used to catch big fish. This is a bigger cast net. 5 yards in length; about 13 ft. radius; 18 ft. Central rope; 1 inch mesh plied from mid waters.

OOSA VALAI

Just like Ooduvalai Cotton 2½" mesh; drift net. This is improved Oodu valai. Fish are caught by their gills or fins.

MALABAR HEMP DRIFT NET.

Of equal measurement as Oodu Valai. Oblong floats of 6 to 10" long and 1½" sq., across section are used as weights. The number and frequency depend upon the depth at which it is operated.

DIP NET.

Generally operated from a bank or a canal by hand or pullies. A flap is also attached so that the fish may not escape, This is useful for colle-

cting fingerlings, since the mesh is very close and the fry do not get injured to take out fish caught another small hand net is used.

OTTU VALAI

A laddle like net, varying in length and diameter. Used to catch fish in flowing waters near dams. Simply wait with the net at the falls or places where the fish ascend the waters and jump. The net should not be manipulated lest the fish would be scarred away.

PLANKTON OR TOW NET.

To ascertain planktonic life in a pond, this net is used. If the net is lowered to 30 feet depth and the area of the cross section of the net is 3 feet, then 30X3 sq. ft. is equal to the volume of the water through it passed. Then calculate how much plankton is collected in the vessel tied at the bottom. Drag the net at different levels; bottom, mid-column and surface, and ascertain what kind of Fish can thrive in the waters-ie., surface, mid column or bottom feeders. The contents of the vessel are examined to see what kind of food is available and to ascertain if the pond is overstocked with reference to the food available.

RANGOON NET.

16 pieces joined at the ends. Each piece is 50 ft. long. This stands like a screen with floats over head made of high wooden pipes. No weights

are used below. Hence it can drift along with the current. This is a peculiarity in this. Mesh 2" sq. generally Very fine cotton or 20 counts used. One end attached and the other end left afloat to the bottom by a heavy stone. Most successful, experiment in deep water fishing. Originally intended for Hilsa used in flowing water.

NALU VALAI (RAJU VALAI))

One piece only. 150 ft. This net is another type of wall net. The differences are (1) Cotton make, (2) length. It is taken across shallow area and two pipes are driven home into the soil. It stands erect in the form of a screen. Usually the two pipes at either side sweep the net in the water when fish are entangled. They may also close up forming a circle, with the net enclosing the fish. These fish when they try to escape out of the cordon get enmeshed. This is not used in deep waters. Extensively used by poachers. (A modified Oodu Valai.)

This is 6 ft., deep and 5') to 100 feet long Burnt clay balls of about 1" in diameter used as weight and cylindrical floats made of hollow light wood, 3" to 4" long are used. 1½" mesh of 1mm. diametre thread i. e. 12 ply thread.

KALLU VALAIR.

A simple cast and shore net. This has no ring and a cord running through it as in the case of nets 1 and 2. It is worked by whirling in the water

when all the lead weights are settled down having been scattered away. The net spreads as a result of this over the water and the fisherman then dives into the water and collect all the lead weight into one place and turn the net upside down - thus making it as a bag to carry the fish caught into it and comes out. The height is 6 ft. 5 inches. Circumference of the open end is 32 feet. Mesh 1 inch square. This is made of very coarse stout cotton thread. Extensively used to fish in shallow waters, the bed of the river which will not be free from any rocks etc, and in deep pools. This is a favourite net for fishermen and extensively used by poachers for fishing in the sluice channels.

WALL NET. (OODU VALAI)

Anchor or wooden peg driven into earth. Floats - small bits of hollow reed or floats of calatropis strung through the rope. Sinks are earthen balls burnt, passing through the cord. Made of common coarse hemp. Three pieces - each hundred feet. Breadth 2½ feet. Mesh 2" sq. and also 1¾" sq. There are two types. One end of the net is fixed to the shore by a sharp pointed wooden peg tied to it. Then the fishermen get into the water by a coracle and paddles away simply plying it into deep water as they proceed. After the net is cast, it slowly settles to the bottom it sinks because the floats unable to sustain the weight of the earthen balls below. After it settles down, it stands erect in the form of a curtain by the help of the floats. Only the bottom feeders are caught by this net. Extensively used in deep water fishing (100 to 200 ft. in length).

NIGHT LINES.

This contrivance is used to capture Wallago Otter, murrel and other predacious fish. A live frog is attached to each of the hooks. The frog is bloated by means of Straw tube introduced in its anus and blown up. The bloated frog do not sink down and will be kept in position, inviting the fish.

Night line with moveable float. This is used to capture strong fish. Best for Crocodile. The moveable float travels along with the fish when it pulls and thus the line cannot be broken.

THE MURREL BROOD TRAP.

The eggs of murrel when free float. The fry is of red colour, and when it is seen put the trap over it and when the bottom is deep, pile one trap over the other, till the last one is partly above the water level, so that the fry may not escape. The fry should be left in the trap till it grows sufficiently for transportation.

PANDAM OR LONG LINE OF HOOKS.

This consists of 50 to 100 hooks attached to strong thread. Small fish etc., are put as baits and both ends are tied to the shore.

CHAPTER. VII.

GOLD FISH- THEIR CARE IN SMALL AQUARIA.

(By E. C. Fearrow)

SUITABLE FORM OF AQUARIUM.

Because of its narrow neck, the so-called fish globe is not adoptad to keeping gold fish in a comfertable healthy state, its small amount of water surface not permitting the process of absorption of air on a scale sufficient for the well being of the fish. Another objectionable feature of the globe lies in its reflection and refraction of light rays which tends to make the fish nervous and uneasy.

An aquarium with straight sides is the only suitable form. It should be of rectangular shape and equal width at the top and bottom. The rectangular battery jar of 5 gallons size will give good results. The depth of the water should be the same as the width of the aquarium and the bottom should be covered with clean sand and pubbeles are the best for this purpose as the more desirable aquarial plants draw most their nourishment from the water and require merely an anchorage. In order to ensure an abundant air supply, plants of high exygenating powers should be selected for the aquarium.

SUITABLE AQUARIAL PLANTS.

Among the most suitable plants for aquarium are ANACHARIS & FANWORT. Anacharis canadensis gigantea is a good oxygenator and at the same time provides forage for gold fish. FAN-

WORT CABOMBA CANALINUANA is a very hard species and thrives well in small aquaria. It is ever green and will grow from cuttings especially the forked joints and a branch planted at the bottom in the sand will produce roots. These plants are very common and supplies can usually be purchased from gold fish dealers. Other desirable aquarial plants are WILLOW MOSS FONTINAPIS ANTIPYRATICA (Fig. III) AND ARROW HEAD SAGITARIA NATANS (Fig. IV) Very beautiful aquatic gardens may be made by a proper selection of plants. A frequently used and very hardy and beautiful plant is the HORN WORT.

It requires careful attention as it is liable to decay and contaminate the water. Moreover it is dormant in winter and has only decorative value at that period. LUDWIGIA-LUDWIGIA GLANDULESA highly prized for its fine appearance in the aquarium and is easily propagated from cuttings.

BALANCED AQUARIUM.

When the relationsip between plant life and animal life in an aquarium are properly proportioned, the aquarium is said to be self-sustaining or balanced and under such a condition the water requires no change. Filling in to make up what has evaported is all that is necessary or if preferred half the water may be drawn off through a siphon and a similar amount of fresh and aerated water added. During very warm weather this will probably have to be done about once a month. If the water should become vitiated at any time the aquarium should be

thoroughly cleaned and the entire water supply renewed, the fish first having been removed to another vessel. When fish became restless and rise to the surface of the water to breathe, it indicates that the oxygen supply in the aquarium is insufficient. Relief may be given to them by dipping up and pouring back some of the water.

A small aquarium cannot sustain much life. Fishes like human being cannot thrive in crowded habitations and thousands of gold fish have been lost by the overstocking of aquaria. The number that can be maintained in healthful condition in a 5 gallon vessel will depend upon it's location and shape, the water temperature, character of plant life, size of the fish and the amount of life admitted.

It is better for the beginner to start with a few of the hardened varieties of gold fish until the fundamental principles of aquarium keeping are understood. When common gold fish can be kept, with no losses, it is time to launch out and undertake the keeping of the more interesting weeds.

A well balanced aquarium of 5 gallon capacity is capable of maintaining 2 gold fish each 2" long exclusive of one frog tadpole and 4 snails. One fourth of the bottom area should be planted with aquatic vegetation, the ends of the roots to be embedded from 1" to 1½" in the sand or gravel and the plants evenly distributed over the entire surface to admit light and provide for the free movement of the fish. In choosing the snails, select the species that do not feed on plants. The best are the Planorbes and Vivepara. Snails help to keep

down the growth of algae while tadpole acts as a scavenger consuming all waste matter in the aquarium. When about to enter the frog stage, the tadpole must be provided with a resting place on the surface of the water otherwise it will drown. In a 5 gallon aquarium, 2 handsome specimens of Fringe tail gold fish will make a fine appearance. Once or twice a week the inside surface of front the glass should be cleaned to prevent obstructions of the view by the accumulation of algae. For this purpose a flat sponge or a piece of felt attached to a flattened end of a stick will be effective. Sediment may be removed by a glass dip tube or rubber siphon.

A 5 gallon aqaurium is the minimum size recommended, but when it is possible a larger size should be used. A tank 24" long 12" wide and 15" high with a capacity of 18 gallongs makes a suitable aquarium for a parlour or a living room. A receptacle of that size should maintain 5 two inch fish of different types and varieties, 2 tadpoles and 10 snails. When large aquaria are used, the number of fish scavangers and plants may be increased proportionately. If the fish are larger, their number should be correspondingly reduced. A good rule in stocking an aquarium is to allow 1 gallon of water to each ½" of fish.

LIGHT.

The aquarium should have a northern or southern exposure in summer but in winter it is advisable to so locate it that it will get the sunlight 2 or 3 hours a day. The light should enter an aquarium

in about the same way it enters a stream, from the surface of the water. Too much water will overstimulate the growth of algae causing the water to turn green.

WATER.

Best water supply for an aquarium is nearly always from a river, pond or cistern, as water from such a source conforms more nearly to natural conditions. Well water usually contains lime or salts, especially lime, making the water hard and entirely unsuited to the purpose.

TEMPERATURE of the water in an indoor aquarium will range from 50 to 80 degrees F. in winter and from 65 to 80 degrees F. in summer. In summer temperature somewhat in excess of 85 degrees F. should not prove harmfull if the water is well aerated but if the fish shows signs of distress, their condition may be improved by reducing their number in the aquarium. In all cases sudden changes in the water temperature should be avoided.

REPLACEMENT OF MINERAL.

Provision should be made to replace minerals that are constantly absorbed from the water by plants and fishes. This can be done by occasionally adding salts, a mixture of 3 parts of evaporated sea salt and one part of Epsom salts. A level teaspoonful to 20 gallons of water about once in 2 or 3 weeks is considered beneficial. The fishes will usually swallow these salts which act as a mild cathartic.

PREVENTION OF ACID CONDITION.

For the prevention of acid condition in the aquarium whch is usually brought abcut by the decomposition of plants a small piece of plaster of paris in the aquarium is recommended. The plaster of paris neutralises the acid and as it dissolves only under acid conditions, there is no danger of getting the water too alkaline. When the plaster of paris dissolves quickly it is a sure sign of acid condition.

FOOD.

Most aquarium fishes desire a variety of foods and the aquarist should endeavour to imitate natures. Whatever foods are used it should always be borne in mind that a balance of vegetable, animal and mineral content is required. The best prepared foods are those that are granuler in form and usually of dark colour. Such foods may be pur-chased at stores and they contain a mixture of flour, fish roe, meat etc. Dried bread crumbs are frequently recommended as food for gold fish especially when whole wheat bread is used.

Gold fish in an aquarim should be fed *every day in Summer* and *every other day in winter*. Substitues for natural foods as scalded and dried earth worms, dried liver, fish roe, and eggs, rice flour, pea flour etc. Many combinations may be used, the best ones being those containing animal crustacea and strachy ingredients together with some digestable form of lime, such as powdered egg shells, table salt and Epsom salts.

A well-known Gold Fish food consists of 5 ozs. Pea flour; 4 ozs. rice flour; 2 ozs. dried and powdered fish flesh; ½ oz. finely divided dried meat fibre (beaf heart), 2 ozs. dried Daphnia; 1½ ozs. ant eggs (pupae), 1 oz. dried powdered prawn (shrimp or lobster); 2 raw eggs together with powdered shells; ¼ oz. table salt; ⅛ oz. Epsom salts and sufficient gum arabica in boiling water to bind the mass. This is thoroughly, kneaded into a thick dough, dried at a low temperature and crushed into convenient particles, making about a pound of dried food. Just before feeding, the granules are steeped in luke-worm water or they may be forced through a colander or other device to produce a Vermicelli like form. It is the opinion of a good authority on gold fish that this food contains too much animal substance to get entirely satisfactory results.

Prepared foods containing many of the ingredients mentioned are for sale in the market and their use can be recommended to the amature aquarist. The main thing to guard against is the giving of more food than the fish can consume at one feeding as any excess allowed to remain in the water will eventually pollute it and produce deseased conditions.

Daphnia popularly known as "Ditch fleas" are an excellent live food for gold fish. The same may be said with reference to the larvae of mosquito which can be had in large quantities during the summer months and may be found in rain barrels or Stagnat Pools, the common name being "wrigglers",

DISEASES OF GOLD FISH AND THEIR TREATMENT.

Illness among gold fish becomes apparent in many ways, but as a usual thing, the fins are blood shot, the dorsal fin drops the affected fish is inclined to rest on the floor of the aquarium with little or no desire for food. Where only one fish is diseased, the cause may be attributed to overfeeding or constipation; but if a number are ill, it is an indication that something is radically wrong, either with the food; the water, the oxygen supply for the temparature conditions.

The excrement in healthy, is dark, either a brownish green or black. If white or yellow it indicates overfeeding. When a fish becomes diseased, it should be immediately removed from the aquarium.

Gold fish must be handled gently and as little as possible to avoid injury to their scales, fins or tails. The dip nets used for their transfer to and from the aquarium should be round and somewhat deep rather than funnel shaped. If it can be avoided, fish should never be grasped by the hand.

Sudden changes in temperature produce the diseases known as 'white' fungus and 'tail rot' when whitish coating or splitting of the fins is noted, the affected fish should be placed in another jar containing water, just saltish enough to be noticeable to the taste and kept there until cured, the

salt water being changed daily. The treatment is good for run-down fish as well as those that are diseased.

To overcome constipation, dissolve a table spoon of Epsom salts in a gallon of water and allow the fish to remain in the solution for a few hours if necessary. Then let them rest a day or two in a mild solution of Epsom salts with a little sea salt added. Constipation can be prevented by the use of live foods such as Daphnia at intervals.

Fish accustomed to a lighter temperature than that which they are accustomed to are apt to develop fungus or other diseases. When fish is brought in from the open, the temperature should be gradually lowered and over crowding prevented. At the first indication of fungs (white spots on the fins) the fish should be given a salt treatment after which they should be kept apart from the healthy ones in well aerated water.

Fungus is a parasitic plant and species of it are more or less abundant in the water. Healthy fish usually have the strength to resist, but those injured by in judicious handling are liable to become affected. The fungus will be observed as white and black spots or the fish may have most of its body covered with slime. A storong salt solution applied with a Cotton Swab will affect a cure in one or two treatments. There are preparations in the markets that are sometimes used for painting spots made by fungus. These preparations which are insoluble in water and act as a covering while the wound is healing.

In their use, the affected parts are cleaned and dried and the preparation freely applied with a small brush or a piece of cotton and permitted to dry for about 3 minutes, the head and the gills being wrapped in a wet cloth, while the operation is in progress. If properly done this will not endanger the life of the fish. The following methods of salt treatment are in common use.

TREATMENT WITH STRONG SALT SOLUTION,

A solution containing 13 ozs. Common table salt per gallon of water is prepared. The fish are put in a deep net and lowered in the salt solution where they should remain for 2 or 3 seconds. The fish are transferred to another vessel containing well - aerated water of the same temperature as that from which the fish were taken. This treatment may profitably be given daily for 2 or 3 days.

TREATMENT WITH DILUTED SALTS.

In this case, the fish are placed in a 3% solution of common table salt ¼lbs. to a gallon of water. and allowed to remain in the bath with aeration of the solution for 30 minutes. The fish may then be placed in another vessel containing well aerated water. If the fish shows signs of distress or during the half hour by turning on one side, they should be removed to fresh water. Treatment may be repeated daily in the following 2 or 3 days.

On cloudy days even in well conditioned aquaria, fishes will come to the sur face of the water

to breathe, but if they do this in clear weather, it is a sign that some thing is wrong, The trouble may be from one of the following courses :-

Too few plants; too high temperature or decomposition of unconsumed food. The cause should be found and removed as quickly as possible.

Gold fish are subject to many diseases not discribed in this publication, among them being inflammation of the eyes, as affection of the swimming bladder, dropsy and consumption. The last two are usually fatal. It is not possible to enter into details concerning these diseases and their treatment Further information on the subject may be obtained from the standard books on gold fish culture, a selected list of which is herewith appended. Many of them are avilable in public libraries.

HOW TO DISTINGUISH SEXES IN GOLD FISH.

The gold fish as well as in other fishes the male and female are so similar in external appearances that sex can be determined only by an examination of the initial sexual organs. The following extract from "Aquatic Life" will be of interest to another aquarist.

"Quite the first question, to be asked by one desiring to breed gold fish is how the sexes may be distinguished. It has been shown that a slight

difference in Contour, exists in the region about anus, but it is exceedingly hard to discern and not a few experienced fanciers will refuse to guarantee the sex of a fish on this feature alone.

When in condition to breed, the distinguishing points are very evident. The male develops tubercles on the gill plates and along the first ray of the pectoral fins. These marks may be absent from the fins but few in number on the gill plates. The tubercles are usually considered as infalliable distinction but are not absolutely so. Once in life time, fancier may found a female with tubercles.

The female, expect about the anus, exhibits no sexnal difference until the development of the roes causes a distention of the body which is more evident from a top vein than from the side. If both the sexes are in the same tank, precacious males may 'drive' barren females and in that manner aid in identification, but a doubt may be cast on the certanity of it by the fact that males will sometimes drive other males.

CONCLUSION.

Cleanliness, good light, plants well distributed over the bottom, proper food in moderate quantity scavengers, prompt removal of sick fish and avoidence of over-stocking, are the essential features for the maintenance of a successful aquarium. Thousands of gold fish have lost by lack of observation of a few simple rules and many are lost through mistaken kindness. The globe in the

sun light is a veritable torture cell. Avoid tapping on the glass, as it frightens the fish. The fact that gold fish can endure a great deal in the way of unwholesome environment is not an excuse for furthering them. More-over, with proper care, they will thrive and attain a great age.

"THE AQUARIST AND POND KEEPER."

(BY C. LESLIE CALDIER.)

BREEDING GOLD FISH.

Climatic conditions seem to have no great effect on the tropical fish in domesticity or on the activities of their culturists.

We have spanned, raised our young fish and housed them comfortably for the winter and thus the cycle has been completed. Some culturists advocate waiting until after the second year is passed for pairing up breeders, but I see no reason why if the fish are so inclined they should not be allowed to produce a family at 15 to 18 months. I have crossed 18 months old males back to the females and females with male parents with very great success. In fact by carefully choosing the young breeder in relation to the older one, the combinations have produced better off-spring than any before obtained. Better indeed, than a well chosen half-brother to a half-sister combination. The method of breeding combinations must be left entirely to the descretion of the aquarist himself. There is no set formula, but always to be remembered is the fact that points good or bad are accenuated when breeding closely. For example, the male

with a tendency to be 'thick' at the candal peduncle crossed into another fish inclined to be short, in finage, will almost certainly result in a family of young with short tins and tails much too small for the girth of the fish. But the results from promiscuous crosses have never to my knowledge have been tabulated or recorded. The variety of results must be endless.

It is a fact that any two fish will produce the same type of off-spring time and again. It is useless having 'proved' a pair to spawn them again hoping that they will do better next time. A study of the article "From Egg to Embriyo" by Mr. Fraser will give an inkling as to the whys and wherefores of this fact. Losses may occur and when they do there is only one maxim grin and bear it. Pitfalls and traps for beginners abound but I consider that the allure of the fancy Gold Fish lies chiefly in its glorious uncertainty. When our tropical friend spwan up his fish except for highly specialised varieties, he knows almost to a 'spot' how the young ones will appear even before they are born–his only thrill must be to speculate what the shape of the few inevitable varieties will be with the fancy gold fish, the matter is different. Of necessity we must from each hathing, raise hundreds of young in order to produce just a few really good fish always hoping that by a steady progressive work along clear lines, one day we might find a complete hatch of perfect fish. This to my mind is not so fantastic as it would appear. Although I have mentioned earlier of the 'reversion to type', deep down in my heart, I feel that this

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need not have been so, for I consider that it is only the "monkeyings" in fairly recent years, this "taking short cuts" thus has brought about the unhappy state of affairs now existing. The development of the varieties of Fancy Gold Fish has been established sufficiently long that the types had been kept sufficiently 'clean'; reversion should be a thing most unlikely. No one interferers with a new type – the comet – another comet when crossed to a comet – produces nothing but comets. There has deen no reason to try fancy crosses with this type and therefore they remain fixed.

One thing that I have until recently not proved to my satisfaction to be fact, is now established. I have raised the young from a female fish which bore tubercles. I ofcourse, accepted the written and spoked word of authorities on this subject, but it is so much more satisfactory to have really witnessed this.

Just one more piece of advice before I finally leave you. When your fish are housed for the winter, do not be tempted to over-Crowd. Remember the fish are to be subjected to a rather 'trying' period, for live foods will be scarce and in this respect it is advisable to have a few cultures of 'white worms' on hand. Over-Crowding will possibly retard growth and disease more liable to occur, and when it does will run through the fish with greater ease and with disastrous results than if the fish have adequate space. The fish MUST grow, make allowance for this, when allotting tank space. Aeration is a decided asset.

If possible also a small immersion heater for the very coldest weather. I do not suggest that the fishes should be treated as tropicals but they should have Suffiient Warmth to keep them feeding and this should not be under 50 °F. 60 °F. is better and for the long finned Varieties such as veiltails, a few degrees over 60 °F. will ensure against fin congestion which spoils the appearance of so many other wise gcod looknig fish. If the temperature is maintained through the winter over 65 °F; When the spring comes round again, you will not safely be able to use extra warmth as stimulation for early spawnings. May be your pond is about 3 ft deep, this being so you might like to have a few of your Fancy gold fish out for the winter. Don't risk them all for I can assnre you that the risk especially when calicos are concerned is very great. Despite many claims to the contrary, when the water is still, it is only a fish that comes through well 1 have taken delivery in April of some calicos from Professional establishments that have wintered out doors and I can assure you they were pretty ghastly to see. Had they been allowed to come to 'in their own pond' the story might have been slightly different, but netting and a journey plus new conditions was just the climax to months of wretchedness and the fishes quit – who can blame them ?

CARASSIUS AURATUS.

Its orgin is the Orient, and widely distributed in Ponds and aquaria widely distributed over the world. Thrives best in water containing lime and not over 70° nor below 55 °F. Mates early

morning to afternoon, April and May laying 10 to 20 amber eggs at a time tatalling over 500, which stick to Submerged or floating plants; hatch at 70 °F. in 3 to 7 days. Good breeders have bodies at least 2 inches. Matures in 2nd year and breeds until 9 years. May lives till 15 years.

GENERAL

Gold fish live as long as a dog or cat.

Bodily construction:- Usually 3 single, pectoral, ventral Dorsal or candal fins.

How gold fish breathe:- They breathe oxygen through water and give out carbon-dioxide, the plants absorb. Must have a large surface of water. Sudden change in temperature is detrimental. Feed them morning and evening. 3 inches long fish Consumes food that can be piled on 6 d. coin.

SELECTION OF GOLD FISH :- Dorsal fin must be straight. Shape and well covered flesh.

The depth of the aquaria in which the gold fish are put should be covered with well washed sand upto 2"

How to wash the sand. Keep the white coarse sand to be put in the aquaria in a tub and place it under the pipe. Let the water run into the tub and agitate the sand till the water and sand are clear.

Then place the sand in the aquaria and put a lump made of news paper over it and pour the water, so that the bed of sand may not be disturbed

and uneven. Vallisneria spiralis; Sagiterial nataux are very good to be put into the aquarium. They are good for oxygenating the water. Electric light is a good substitue to sun light. The lamp should be burnt about 8 hours a day. Introduce tadpols into the aquaria to eat decaying matter and to act as scavengers. But do not rely on them to do everything. When you find brownish sediment, take a syphon and clear it. Eggs of the snais are very good food for gold fish. Cover the aquarium with wire net of small mesh or something fancy.

VARIETIES OF GOLD FISH.

Lion heads, and oranbas etc. are worth their weight in gold.

Comet will be like a cobler's tool and a good one. Shubunkin: Scaleless gold fish (Scales are transperant)

Though it is in various colours, blue is considered to be very good in this.

Fantail:- Clubby body, double tail, very desirable one.

Nymph:- Short rounded body and not so common.
Black:- a-moon: a jet black fish.

Breeding of gold fish. 2 feet × 1ft. × 1ft. tanks are ideal size for a bigger specimens. Put Chara in them. Two tanks are necessary. They breed only when animal food is given. Earth worms chopped nicely and given for 3 or 4 days will do well.

To ascertain the male and female put them in the tank and if they are chasing each other continuously, they are both males and should be changed. Snails should not be introduced into the breeding ponds. Two males to a single female should be introduced. The male chases the female in the early morning on a bright day or evening the time of spawning is 2 to 5 hours. The parents are cannibals. So the plants on which the tiny eggs are adhering, should be taken out and put into another tank. Best method of seperating is to take out the parent fish. 6o to 65 degrees F. is optimum temperature for breeding. For the first 48 hours the baby fish do not take any thing. They will be found to be attached to the weeds in the aquarium. Afterwards they require abundant food. Powdered fine oat meal or pea floar (Patani in telugu, cooked to the consistency of rather stiff paste and squeezed through a piece of fine musline into the water is a good baby-fish food. Hold boiled yolk of the egg (yelow) and press it in between the thumb and forefinger to make a small round cake so that it floats in the water. A pie size of yolk is enough for hundreds of fish. Nursery beds should be cleaned by siphon. Babies are bronzy or greenish in colour unlike their parents. First it is difficult to find out whether they are gold fish nor not. In 4 to 6 weeks, the baby fish are big enough to take other kinds of food. The babies get beautiful colours after 6 months. The attain colours more quickly at a temperature of 62 Deg. F.

Diseases.- The fish must swim erect. If it swims turned to one side, there is some trouble,

Indigestion is common. Starchy dried food is not good if given too much.

Hospital Tank. Small tank with sufficient water 1 gallon ½ Oz. of common salt and ½ Oz. of Epsom salts mixed and kept. Then fish must be introduced into it and left there for 2 or 3 days. Then give it cut lean raw meat, washed minced liver raw-horse boiled cabbage or spinach, finely cut lettuce, rather than continual dried food.

Swim bladder trouble :- Mild cases are confused to indigestion. It floats belly upside, and always at the surface. Place the fish in shallow salt water tank. Diet as above.

Fungus:- Will attack the fish with bruises etc. Place in saline water as above. Paint it with mild potash permangenate solution.

Tail rot :- Red streaks appear at the Caudal fin. Hydrogen paroxide bath for a minute or two will do good.

Gill conjestion :- Swollen and inflamed appearance with milky white patches on gills. Strong salt bath ; 3½ Ozs. salt to 1 gallon of water. Dip the fish and then take it out and put it in a tub under slow tap.

Lice :- Give salt bath frequently.

Fish louse:- get into the aquarium by means of the plants introduced. So before introducing plants-dip them in ,a weak solution of Potassium permangenate.

SUITABLE PLANTS FOR THE AQUARIUM.

Anacharis: Anacharis caneris gigantia (good oxy - genator, provides shade).

Fanwort: Caboma caroliniana (Hardy and grows in small trough

Fontinalis antipyratica (Willow moss)

Sagittaria natans.

Hornwat: Beautiful plant.

Ludwigia glandulosa: fine appearance and easily propagated.

SUITABLE BOOKS ON GOLD FISH.

The book of water gardening, by B. Peter

Domesticated fish. By B. Walter Tannoy.

Fresh Water aquarium and its inhabitants, by Otto & Fredrick Gold fish verieties and tropical aquarium: Fishes :- By I. William.

Gold fish and its systematic culture by M. Huga.

Aquaria: By P. Charles.

Aquatic life by W. A. Poyow.

The Amatur aquarist: By Samuel Mark.

Japanese Gold Fish:- Their Varieties and Culture by Smith High M.

Gold Fish Breeds and other aquarium fishes: by Wolf Hermann.

FEW HINTS ON GOLD FISH CULTURE.

Put plenty of water plants that grow from sand.

Cats and King fishers are enemies.

One Gallon of water for every fish.

Introduce fish after plants are established.

Near surface swimming means more oxygen required.

Do not keep the trough near a sunny window.

Do not move from warm to cold water; sudden change of temperature is bad.

Do not hold gold fish by hand.

Scraps of lettuce are good.

Ant eggs are good.

Soft bread crumbs dirty the pond.

Drooping fins and dullness are not healthy signs.

While giving salt bath, if it turns over back, remove it and introduce in a graded saline water,

Gass light tank is best to give aeration for fish.

The gold fish spawns 3 times in a year in an uneven pond with plants.

It breeds successfully for 3 years.

The females must be changed every year or 2 years better.

Iron salts give good colouration to the fish.

Carassius auratius is a common gold fish.

CHAPTER VIII.
FISH - BY - PRODUCTS.

The by-products of the sea fisheries are as follows:-

1. Salt; 2. Iodine and potash; 3. Agar agar; 4. Pearl; 5. Corals;

6. Chanks; 7. Fish oil (from body and liver); 8. Fish guano;

9. Fish meal; 10. Fish manure; 11. Glue and isinglass;

12. Leather; 13. Whale products; 14. Sponges;

15. Turtles; 16. Beach-de-mar.

1. Common salt is one of the most important items of the man's life.

2. IODINÊ AND POTASH. Sea weeds or marine algae are burnt to make kelp - ash, which are used as sorces of alkalies in the munufacture of soaps, glass and aluminium, by certain chemical process. Iodine can be extracted from this kelp. Sargasm and Turpmaria are two important sea weeds from which Iodine can be extracted.

3. AGAR AGAR. It is a commercial name applied to dried particularly bleached gelatinous extract of red algae. Ceylon and Chinese agar are prepared from the sea weed called gracellana. These weeds are boiled and heated until a gelatinous material is produced. Agar comes to the market in transparent shades; the colour varies between colourlessness and yellowish pink or black. It swells especially when placed in cold or luke-warm water. It is used for soup, gravies, jellies,

ice cream and sweets. It is also medicinally used by bacteriologists as a culture medicine and for dressing wouds. In the orient it is known for so many centuries as agar agar or agar agar gum. Also used in making scented sticks.

FISH OIL:- Fish oil is extracted from all parts of the fish especially from the body. Oil sardine gives oil from its body. Small Barbus species give oil from their entrails and also from body. This oil is used for seasoning wood such as used in boats; in paints and varnish and also for packing fish in cans. This is obtained by boiling the fish and pruning them.

FISH LIVER OIL. Extracted from the liver of Cod, Halibut and Shark. The oil is extracted both by cold and hot processes. Indian shark liver oil is very ancient in origin and was put to medici - nal use to cure diseases of lungs, eyes and skin. It contains high percentage of nitrogen and it is 2 to 3% more stronger than the commercial cod liver oil. Durng war, foreign fish liver oil could not be imported and this shark liver oil has taken its place admirably and is used in almost all hospitals. It is used in dressing wounds and it heals them up admirably.

The liver oil of wallago attu is said to be 25 times more potent than the cod liver oil used for vitamin 'A' content, (for detailed work see P. K. SESHAN'S article on "Vitamin content of liver and deposits of fats of some Indian fish", appeared in the Indian Journal of Medical Research XXVII P. P. 711 to 720 of 1940.)

FISH GUANO. This is the eke remaining after the body oil has been taken out. From guano, manure is extracted. This is pulvarised and the powder is de-odorised to make it palatable for cattle and poultry. This contains good percentage of protein and phosphates which are essential for the rapid growth.

FISH MANURE.

Fish scrap and the waste from the fish fins are good fertilisers, for their high nitrogen contents. It is generally mixed with the other fertilisers to vary its composition to suit a particular crop. Fish fins and entrails and other waste material can be burried along with the kitchen refuse in a small pit dug out in the back yard. After a short period, this decomposed manure can be used advantageously.

FISH GLUE.

Fish waste mainly the head, bones and skin are collected and the salt and other waste is removed from them. Then they are cooked with water and the glue liquid is drained off and evaporated. Glue is also made from the water in which fish are cooked in canning factories. Fish glue is used in photographic enlarging work and in the manufacture of pastes for lables and stamps and in book-binding. It is also used in the manufacture of translucent glass.

ISINGLASS:— It is a cured product of the air bladder or fish sound. The air bladder is a hollow compressable bag like structure containing gas and situated in the abdominal

cavity just below the back bone in many of the bony fishes (Cat Fishes, Indian Salman, cockup (Nairfish) etc.) The air bladders after they have been removed from fish are slit open, washed well in sea water and dried in the open air. The cured product does not dissolve in cold water but simply swells up slowly. It is used in the preparation of food jelly, confectionary, in the manufacture of plaster and special cement as a consistent of water proof composition. It has taken the place of gelatine in many ways. On an average about 5 tons of air bladder were being exported from West Coast to Singapore, Penang, China and Japan; the price varying from Rs 2-8-0 to Rs 3-0-0 per 'Tulam' of 32 Lbs.

This air bladder or swim bladder is in a measure comparable to the lungs of higher vertibrates. It's chief use is to serve the fish as an organ of equilibrium, ading the animal in rising and sinking in the water. This is associated with the "voice" in fishes. The croaking of the fish is due to the pressure of highly developed air bladder.

LEATHER.

Skins of seal, shark, whales, crocodiles and other large fishes and large intestines of whales are used as leather obtained after proper tanning.

<u>How to remove skin of a crocodile.</u> Turn it on the back so that the belly is shown up. Cut straight down from the neck to the tail from the side. Then remove all the flesh and severe the head and salt it. The skin on the belly should not be cut into pieces as it is important.

SEMI DRIED PRAWNS.

Prawns which are available in very large quantities on the West Coast and East Coast of the Madras Presidency are cured in a special way. The Department of Fisheries has evolved a process of preparing semi dried prawns which almost look like in appearance the Pary's losenges. They are very attractive, quite palatable and very good as food. The process of preparing them is as follows:- They are boiled in five percent brine till their shells get reddish in colour. Subsequently the shells are peeled off by hand and the peeled prawns flesh is put in saturated brine 24 °F Hydrometer for about 10 minutes to one hour. After draining it off they are spread on coil thatties and exposed in the sun for about 8 to 10 hours and when they get dried to a consistency, the flesh if pressed between the two fingers, just yield to pressure like that of rubber, it is considered that it is sufficiently cured. The stuff is then packed in butter paper and sent to the market for sale. There is a very good demand for this kind of product both from the European and Indian public. On a large scale ordinary fishermen expose these prawns even without peeling the skin or exposing the prawns to the sun. After completely sun drying them the shells are removed by putting these sun dried prawns in bags and beating them up; Of course it is not so good a product as the semi-dried prawn prepared at the Government Factory, but it is a cheap product quite good enough for consumption by the poor classes.

CANNING PRAWNS.

In canning prawn, remove the head and shells of the prawns. Thoroughly wash the meat in two or more changes of water and it is ready for 'Blanching'. The blanching consists in boiling the prawn in salt water; about 1 lb. of salt being used to each gallon of water. The meats are usually placed in a wire basket and this suspended in the boiling brine in a kettle. The time of the blanch is usually 4 minutes for the wet pack and 5 minutes for the dry prawn. When removed from the shell, the meats are white or slightly grey in colour. The boiling process makes or cans them to become bright pink or red. Next spread the meats thinly on wire-meshed trays and exposed to a free circulation of air, which soon results in their proper cooling. As soon as cooled, fill the meats into two types of cans, holding about 4½ and 8 ozs. respectively.

Canned prawns are put up in what are known as dry and wet packs. In the former no liquid is added while in the wet pack, brine is used. The wet pack keeps the material flavour batter than the dry pack.

After filling put the cap on the cans and process them in steam tight retorts. In the case of wet packs they are processed at 240 °F for 11 to 12 minutes; the process for dry pack is 60 minutes to 75 minutes at 240 °F for 4 hours at 212 °F. Great care must be exercised in handling canned prawn until the cans are thoroughly chilled.

The pulp made from prawn by grinding up the blanched meat and adding salt and flavouring, are becoming popular and can he kept in air tight tins after processing for 4 hours it 212 °F.

(From 'Industry' September 1945.)

PRAWN AND CRAB FISHERY IN MADRAS.

By K. Chithambaram B. Sc., and R. S. V. Raman B. Sc.,

The prawn and crab fishery of the West Coast of the Madras Presidency (and on the East Coast at Akiveedu and Ponneri) is very extensive and valuable and constitutes a major part of the general fisheries. Prawns and crabs dwell not only in the sea but in estuaries and backwaters as well. Hence, the fishery extends to these regions too. As an article of food, these crustaceans are a delicacy with the rich and the poor. Prawns and crabs are a common sight not only at the costliest banquests, but also in the miserable hovels of the poor, where no doubt it is the chief luxury.

STATISTICAL STUDIES.

Statistical studies have revealed that the prawn and crab fishery figured largely in the fisheries of the West Coast from 1931-32 to 1936-37. During this period its ranking has invariably been 1, 2, 3, and 4 among the economically important fishes that constitute the primary fisheries of the coast. For some years to come, the fishery of 1931-32 will rank as the best when a record was set up, both as regards the quantity landed (7,965 tons)

and the amount it fetched (Rs 2, 65, 495). On an average, about 4, 082 tons are annually landed on the West Coast, and the return by way of income is 1, 21, 391. Eollowing the season of splenty in 1931-32, there was a slight fall in the fishery, which extended for a period of five years (1932-33 to 36-37) and then gradually declined to such an extent that in 1940-41 only 997 tons were landed; which figure up to this date is the lowest ever recorded. It is proposed to investigate the causes responsible for this progressive decline in the fishery at the West Hill Biological station. The crab fishery, by itself does not figure prominently. On an average 23 tons are landed annually and the value realized is Rs 886/-.

COMMONEST VARIETIES.

The commonest West Coast prawns and crabs are Penaeus semisuleatus (Mal. Valiachemmen); Peneaeopsis dobsonii, (Mal. Kozhi chemmen); Parapenea-opsis stylifera (Malayalam. Karikaddi); Metapenaeus affinis (Vallai Karikkadi Neptunus sanguinolentus (Malayalam. Kannu Nandu) and Charybdis crucifer (Kall-nandu).

THE SEASON.

The prawn and crab fishing commences with the breaking in of the south west monsoon in May and extends to October. When the monsoon is on, the sea is so rough that it totally prevents sea fishing till it has blown over. During that period the prawns and crabs occur abundantly providing the fishermen of the coast with employment and

means of sustenance, and the fish-eating population with delicacy and variety. It is in that fact, and in the part which these crustaceans play in the food chain of the sea, that the importance of fishery lies. In the sea the larvae of prawns and crabs float passively on the surface as tiny organisms. These form the food of surface feeding shoaling fishes like oil sardine and mackerel. The adult prawns are largely eaten by the predaceous fish such as shark, ribbon fish, jew fish cat fish, cock-up, thread fin, horse mackerel sole, anchovey, big-jawed jumper, white bait and rainbow sardine.

NUTRITIVE VALUE.

The nutritive value of prawns and crabs is not so high as fish flesh, due to the lesser percentage of fat. Yet the flesh of these crustaceans contain highly nutrient substances like vitamins B and C, carbohydrates, proteins, that are required for the building up of the muscular system, iodine, phosphorus, magnesium, iron, copper, sulphur and calcium which are essential for the general up-keep of health and stamina. The deficiency in fat is made good by the presence of some carbohydrates and starchy nutrients which are unusual in other sea fish.

The carbohydrates occur as glycogen, which is a variation of sugar and is stored up in the muscles. Whereas in other sea food the percentage of carbodydrates is usually less than half of 1 per cent; in prawns and crabs the carbohydrate contents range from 1 to 5. 2 per cent. Further the flesh contains

23% of proteins, as contrasted with 20% in sea fish. The presence of such proteins gives an unusual and delicate flavour to the flesh of prawns when cooked. This adds variety and taste to the diet and wets the appetite. So there lives a scientific truth behind the conventional serving of prawns and crabs at the commencement of the dinner in civilized countries. Such a procedure has been adopted not by pure accident, but by scientific reasoning, as a course with prawns really creates more appetite. Shrimps and crabs are rich in vitamins. It is estimated that lobsters contain 200 times as much iodine as milk, eggs or beef steak. and this has been taken advantage of in the treatment of thyroid disorders. Prawn and crab meat contains roughly half as much calcium more, and five times magnesium and more phosphorous than an equal quantity of milk. From the nutritional point of view, though the food value of prawns and crabs is not so high as fish, yet 'in' no case have any food gained more recognition as having unique dietary values, than have the principal fish prawns, shrimps and crabs'.

CURING AND PRESERVATION.

Since the prawns and crab fishery is so important a substitute for the sea-fishery during the off season, curing and preservation became almost a necessity, particularly when the landings are heavy. The problem of curing and preserving prawns has been seperately dealt with by Mr. P. I. Chacko in his paper 'Prawn Curing in Madras'. The shells of prawns and crabs are powdered after blanching into fishmeal which is used as an excellant feed for

poultry and cattle. Inferior quality fishmeal is used as manure.

A FEW HINTS ON FISH FARMING.

The inland fish farming requires knowledge and industry. The pond culture should have four fundamental requirements. 1. Pond; 2. Proper fish for culture; 3. The producer; and 4. Fishing implements.

REQUIREMENTS OF PONDS.

Seasonal ponds are very food for fish culture. The pond which dries after the season is very productive. When it dries, (1) the nitrogen in the air gets mixed up; (2) the planktonic life grows. Just when the pond is about to dry, run it and grow leguminous crop; (Vempali plant, cut it and put in the bed of the pond and allow it to decay. This will be a good one). By this process, there will be also plenty of nodules. All these will form excellant food for the fish that may be introduced later on. If you have a tank, use it and take every care as you use and care your farm. Remeber the 'Come and Go' story of two brothers; the elder ordring his servants to go and work and the younger asking his servants to come along with him for work in the field. If pond wants further improvement put cow dung when it is dry. Ground nut cake also can be put into it. If it wants corrective, treat it with lime. Shallow pieces of water that dry up after monsoon can be utilised for rearing fry. They are rich in planktonic life. The pond should have good shade. Select quick growing shady trees

and plant them on the bunds. Pithacalobium saman (Nidraganneru Chettu in telugu) grows quickly. The fruits of this are sweet and form good food for fise as well as cattle. Next comes Portia tree (Thespeca populnea. Gangaravi Chettu in Telugu). Cocoanut, citrus, mango trees are also good. The soil of the pond should be fertile and impervious (non-porous), Clay cracks when dries up. So reduce its condition adding loam. Loamy soil is nothing but clay sand and detritus (detritus is the decayed vegetable soil found decaying under trees and it is rich in nitrogen).

PERINNIED PONDS.

Which contain water, year in and year out are not rich in food for fish. Certain amount of organic matter settles down to the bottom in them and gets putrified. If the oxygen in the water is less, the fish connot thrive. For these, therefore, periodically, the bottom should be scraped up and the putrified debris removed. This debris which is removed from the pand bed can be very advant - ageously utilised for manuring the fields. If this scaping the bottom of the tank do not improve, drain out the whole water and correct the pond and refill it. This should be done oncn id every 5 years or at least once in every 10 years. The draining out water and correcting the bottom of the perinniel pond, requires labour and money from time to time and the pond that dries up after the season, when compared to the perinniel pond is the best, in as as much as it requires nothing in the shape of repairs, yet rich in food for the fish. When a new pond has been dug out or old pond silted, it mush

be properly manured. Unless the pond is properly manured, the fish cannot properly grow in the pond.

A small pond of 2/3 of an acre, the water in which was crystal clear fresh water, was found to be unsuitable for fish growing in the beginning. The fisheries department has been called on to improve it. They have found that the pond does not contain any manure and consequently no food for fish was there. Therefore, paddy straw, green gram cow dung, oil cakes were all bundled up after thoroughly mixing and the bundle was kept at the bottom of the tank by means of bamboos. The fish were introduced into the pond and it was noticed that they grew exceedingly well in the pond.

Catla grows slowly in a newly manured pond till the vegetation in the pond is abundant. Manuring all the newly excavated tanks is the secret. The growth of the fish depends upon the quantity of food given and the taste of fish depends upon the quality of food that is given. Flavour can be given to fish by means of food. Prawn meal gives good flavour to fish.

Slow growing fish eat more food and some are of opinion that it is uneconomical to have them in the ponds. At the sametime if the fish grows very quickly, its flesh is not tasty. So the fish should grow tolerably quickly. Gourami breeding will be found uneconomical if it is fed on gingely cakes etc. Thus, economical side of fish culture should be borne in mind by the pisciculturist.

Handling fry is an art and it requires training. Even fishermen who were bread to fishing from childhood, are found to be not knowing how to handle the fry properly.

Suitability of the place for fish to breed should be firrt located. Every person that takes up pisciculture should be a farmer in spirit. Nets require tanning to make them water proof and to last longer. The tackle and craft should be properly cared for.

In a small 1/10 or 1/12 of an acre of pond, 7 lakhs of fish fry were raised. A nulla was flowing besides this pond and it contained all the refuge. The owner of the small pond taking this advantage, drew the water from the nulla to the pond whenever required and this gave abundant food for the small fry. In Bengal the fish eggs are sold by measures – a small cup containing 1½ lakhs of seed costs about Rs. 125/-. The trout being a cold water fish, its eggs can be chilled and conveniently transported. The eggs of Catla, mature in 24 hours and so they connot be transported. The eggs do not putrify and hence no difficulty in tranportation provided measures are taken to admit the growth during the transportation. In larvae form, no conditioning is necessary but fry require conditioning.

A farmer, with a capital of Rs. 1,000/- bought 7 lakhs of fish fry of obout ¾" size and introduced them into a pond of about 1/10th of an acre. As the fry became bigger, they were taken to a bigger

pond where they were installed. Thus retransplantation of these fish in a two acre pond produced 75,000 fish which fetched him Rs. 20C00/-,

There are three kinds of fish; Surface feeders, midwater feeders and bottom feeders. The pond must be stocfied with all these 3 varieties of fish, to exploit it to the maximum. If surface feeders like Catla are only introdueed into the pond, there will. be the wastage of 2/3 of the pond, as the food in mid-waters and bottom will be untouched. Thereof it is advised and is being practiced in Bengal in introducing fish in a pond at the proportion of 65% surface feeders (Catla); 25% Rohu and 15% bottom feeders like Calbasu or Mrigal.

After co••hing the fish in the pond, select those that are to be marketted ond the rest be carried to another pond and introduced there. Transplanting fish from one ponp to anotther gives them a good change and conducive to excellont growth. Seasons should be carefully observed for marketting the fish. Marriage seasons is the best one for marketting the fish and fish will then fetch a good price. Better the fish are weighed and sold. Construct a small cement tank at the marketting place where the fish are kept alive and exhibited for sale. With small hand net take out the fish from the tank when required for sale.

The fish that are stunted in growth are not of good taste. Salanity of a pond is very good for carps. ie. or .2% of salanity is recommended. If the water of the pond is not saline, introduce

salt into it. Salt when once introduced remains in the pond for ever, even though the pond gets filled up with rain water as the water in the pond evapourates.

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VERNACULAR NAMES OF IMPORTANT FISHES.

Latin.	English.	Telugu.	Tamil	Malayalam.	Kanarese.
Aerius.	...	Chintjella or Nallajella.	Karun-galithi.		
Ambasis.	Glass fish.	Akurai; Mullurayi.	Kakasu	Mullucheru.	Mullujubbu,
Ambliphari̇n-godon.	...	Thellamaya.	Ulari.	Wumboo.	Paraga.
Anguilla.	Spineless eel.	Malugu.	....	...	Elangu.
Anabas.	Climbing perch.	Thatigidasa.	Palaeru Kandai.	Undikoli.	...
Haplochielus.	....	Sukkuchepa.	Mundakanni, Paravai; Othapuli.	....	Kud-di-an.
Barbus ticto.	...	Chodupariga.	Vannathi.	....	Kachikaruva.
„ dorsalis.	....	„	Mullakandai.	....	„
„ mahecola.	Black spot.	....	Sevvali Kandai.	....	....
„ tor.	Mahseer.	Gandumeenu,	Bommeen.		
„ Hexa-gonolopis.	Chocolate Mahaseer.	....	Karambai.	...	...

,, carnaticus.	Carnatic carp.	....	Paviri.	....	....
,, malabaricus.	Malabar carp.	....	Kolimeen.	...	....
,, sarana. ,, chrysopama }	Olive carp.	Kannaku.	Panjela; Chanakandai	Mandutti.	Gidpakki.
Berillius bola.	Indian trout.	....	Marithankandai or Arati.	...	...
Belone.	Gar fish.	Wahlahkuddera.	Kokkumeen.	....	...
Bagalius yerreli.	Goonch.	Rathijella.	....	....	....
Catla catla.	Catla.	Botche.	Phopameen.	...	....
Clarius.	....	Marupu			
Chanos chanos.	Milk fish; white mullet,	Palabontha; Kaniselu.	Thullumeenu.	....	Poomeenu.
Chela.	Chilva.	Bedisa.	Velachi	....	Sampaji.
Crisopherdes,	Perches.	Kalamara.	Karupumattava.	Aree.	....
Carcharious.	....	Palasora.	Velliyansurai.	....	....
Caranx.	....	Paralu.	Vannaiparai.	....	....
Cirrhina cirrhosa.	White carp.	Tellagandu-meenu.	Vengadu.		
,, reba.	....	Moju.	Aranjan.	....	....
Cirocenlrus.	Sabre fish.	Mulluvala.	Mulluvalai.	....	Kalli.
Danio.	....	....	Kallukava, Kovvali.	....	....

Elops.	....	Jallugu.	Ullathi.	....	....
Engralis	....	Nethallu.	Nethili.	...	...
Equala.	Indian white.	Karalu or Kommi.	Muthugande, Meesati or puravu.		
Entroplus suratensis.	Pearl spot.	Duvvena-chapa.	Sathakandai	....	...
Gobius.	Indian gudgoon.	Isakadontu.	Uluvai.	....	Gudgeon or Gobi.
Hilsa	Indian herring or shad.	Polasa or Ilasa.	Ullam.	...	...
Hipocanthus.	Sea horse.	Samudragurram.	Kadal-kudurai.	...	....
Harpodon.	Bombay duck.	Vanamatta, Thammarotti.	Pangalamasi.	Gummili.	...
Lutjanus.	Red perch.	Rangu.	Nayikerchi.	Chambolai.	—
Lates.	Cock-up or Nair fish,	Pandugappa.	Kolluva.	Nairmeen.	Kolaji.
Labeo fimbriatus.	—	Erragandumeen.	Selkandai.		
,, calbasu.	—	Nallagandumeen.	Kakameen.		
,, negrocens.	—	Paralu.			
,, contius.	—	Pandimutichepa.	Karamulakandai.		

Lepido ophalychthis and Neimachielus.	Loaches.				
Lactarius.	Big jawed jumper	Sudumu.	Sudimbu, Kuthipu.	Adavu.	Adaimeen
Nacrones Singa	—	Mukkujella.	Nidundala..		—
Aor.		Burrajella.	Kelithi.		
„ punctatus	—	—	Sonankelithi.		
„ cavasius	—	Narajella.	Vellakelithi	Eta.	
„ victatus.	—	Akujella.	Kelithi.		
Magolops.	Ox-eyed herring	Kannangi.	Morangandai.	Kannai.	
Mug il.		Moyyalu.	Madava.		
Netopterus	Barburs knife.	Valligathatta.	Abattankathi.		
Opheocephalus					
„ marulius.	Murrel.	Chavada.	Aviri.		
„ striatus.	—	Poolachepa.			
„ punctatus.	—	Korrameenu.			
„ gachua.	—	Mattagidasa.			
Ophycthys boro.	Borrowing eel.	Mattibukkadam.	Kuthupambu.		
Orizius.	—	Nethigandachepa.	Mundakanni.		
Polynemus.	Indian salma.	Maga,	Kala.	Bameen.	Vameen.
Perioptballus.	Mud fish or walking gobrus.	Nethikandamatta.	Kadurumeen.		

Psleudotropius.	Cat fish.	Chalavajella.	Nakelithi.		
Sillago.	Indian whiting.	Soorangi.	Kelangan.	Poolan.	—
Sachobranchus.	Scorpian fish.	Telujella or Ingilayi.	Telimeen.		
Silendia.	—	Vanjalu or Palajalla.	Ponathi.		
Stromateus.	Pompret.	Chanduva.	Ovval.		
Wallago.	Fresh water shark.	Valugu.	Valai,		

Prawns:— Royyalu in Telugu; Bengali or Hindi; Chingidi. Tamil: Era.

Shrimps: Kunireyyalu.

Cuttle fish:- Kalibinda; Mackerrel:- Kanagadatalu in Telugu; Tamil : Kanangeliti

Sardine:- Kavvallu in Telugu: Choodairuchalai in Tamil.

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